COMPARATIVE STUDY *on*
CUTTING DIATHERMY *versus*
SCALPEL INCISION in
ELECTIVE MIDLINE ABDOMINAL SURGERIES

By

Dr. R. SURESH

Dissertation Submitted for

M.S. DEGREE (Branch I) in General Surgery

April - 2015

The Tamil Nadu Dr. M.G.R. Medical University

Chennai – 600 032.

CERTIFICATE

This is to certify that this Dissertation titled **"COMPARATIVE STUDY ON CUTTING DIATHERMY VERSUS SCALPEL INCISION IN ELECTIVE MIDLINE ABDOMINAL SURGERIES"** submitted by **Dr. R. SURESH** to the faculty of General Surgery, The Tamil Nadu Dr. M.G.R Medical University, Chennai in partial fulfillment of the requirement for the award of MS Degree (Branch I) General Surgery, is a Bonafide Research Work carried out by him under our direct supervision and guidance from August 2013 - August 2014.

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I, **Dr. R. SURESH,** hereby solemnly declare that this Dissertation entitled **"COMPARATIVE STUDY ON CUTTING DIATHERMY VERSUS SCALPEL INCISION IN ELECTIVE MIDLINE ABDOMINAL SURGERIES"** is a Bonafide and Genuine Research work carried out by me.

This is submitted to The Tamil Nadu Dr. M.G.R Medical University, Chennai, in partial fulfillment of the regulations for the Award of M.S Degree (Branch I) in General surgery.

Place : Madurai

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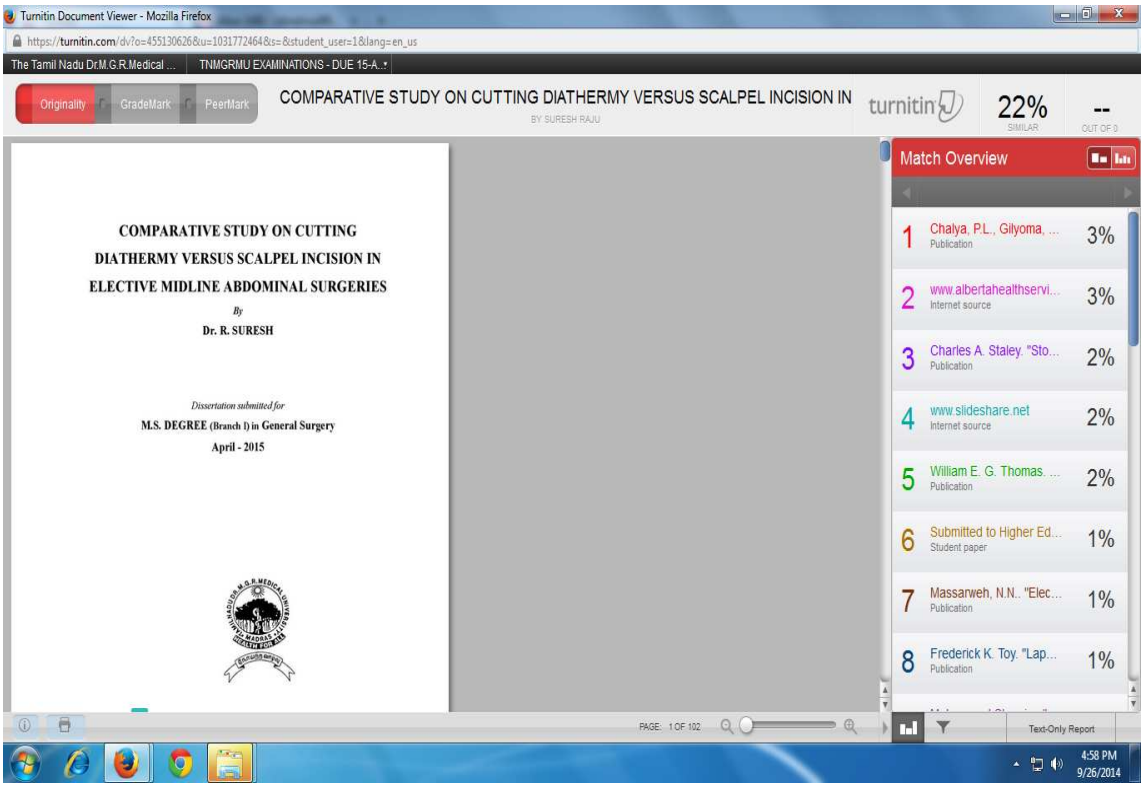
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ABSTRACT

Nowadays there are numerous energy devices available for surgeon. Diathermy is widely available in all Surgical Theatres and are less frequently used for Skin incision due to fear of tissue damage.

This study aims to compare the Efficacy of Diathermy compared to Scalpel in patients undergoing Elective Midline Abdominal Surgeries.

Methods

This is a prospective study on 90 patients who are all admitted in Govt. Rajaji Hospital in General Surgery Department to undergo various abdominal surgeries through midline opening. All patients are randomized into two groups according to which they undergo skin incision either by Scalpel or Diathermy. The variable taken into account for this study are incision line, incision related blood loss, post-operative pain, post-operative wound complications and the results were analysed.

Results

Patients underwent skin incision through diathermy have shorter incision time and less incision related blood loss and there is no

difference in the post-operative pain and post-operative wound complications.

Conclusions

After the study, it is concluded that the Diathermy can be used as an effective alternative to the Scalpel for skin incision. It does not affect wound healing while using mono-polar diathermy in power settings of 30Watts.

Keywords

Scalpel, Diathermy, Post-operative Pain, Post-operative Wound complications, incisional time, incisional related blood loss.

INTRODUCTION

For many years skin incisions are usually made with disposable knives. But nowadays short wave diathermy is proved most valuable and versatile aid to surgical technique. It is most commonly used to achieving hemostasis by means of coagulation by varying the strength of the current it results in cutting effect. These effects are used in both open surgery and laparoscopic surgery.

Electro-cautery which is widely available in all surgical theatres and are less frequently used for skin incisions for the fear of tissue damage.

Recently many studies have shown that electro-cautery can be used for skin incision without any postoperative complications like wound infection, and less post-operative pain.

AIMS AND OBJECTIVES

The aim of the present study is to compare cutting diathermy versus scalpel for skin incisions from all elective midline abdominal surgeries using randomized data with following primary endpoints: Wound complication rate, Incision time, incision- related blood loss and post-operative pain.

REVIEW OF LITERATURE

HISTORICAL ASPECTS

Thermal cautery was used in centuries as early as 3000 BC, where battle wounds were treated with heated stones or swords. Hippocrates cauterized wounds to destroy abscess and stop bleeding in 11th Century. Islamic physicians also used cautery as their religion prohibited cutting human flesh.

The usage of electricity in medicine started in the 18th century. The modern electrosurgical technology begins in the 19th century. The usage of electricity in electrosurgery begins with the static electricity. The second stage begins with the discovery of “galvanisation” effect by LuigiGalvani in 1786.

An Alternating current of frequency 100kHz can pass through the human body without inducing pain or burns. This effect was found by Morton in 1881. Later Arsonval found that an oscillating current as low as 10Khz can be passed through human body without causing pain or burning sensation.

Dr. William T. Bovie, was the first person to develop a commercial electrosurgical device that generates an oscillating current, which can be passed into human without causing any tissue damage. Dr. Harvey Williams Cushing was the first person to use the oscillating current generated by an electrosurgical generator in an real time operation.

After that discovery people found that dream of using electricity in surgical purpose begin.

In 1897, Franz Nagelschmidt penned the term “Diathermy” as a description to the Arsonval’s Effect. Later, Joseph Rivere found that current from the electrode can be able to coagulate the small blood vessels in a particular area of the skin while treating an insomniac patient. He extended the use of this idea for the treatment of non-healing carcinomatous ulcers caused in hands.

Simon Pozzi in 1900s used, higher-voltage, high- frequency, lower-amperes electric current to treat tumors arising in the skin. Simon Pozzi named the technique as fulguration. Earlier electrosurgical devices used a separate grounding plate connected to the earth. Later, this technique was improvised by Doyen where he placed the plate underneath the patient and grounding plate connected to the electrosurgical generator. He noted that the current penetrates deeper and

had an effect on deeper tissues. He named the technique as “Electro coagulation”.

In the beginning of 1910, having understood the basic in electricity principles for the electrosurgical devices used by Nagelschmidt and Doyen. William Clark improvised their instrument by decreasing the voltage and increasing the amperage generated by the machine, which emits a shorter and hotter spark that penetrates deeper into the tissues. In addition to the modified instrument, he included a multiple spark gap for the common single one, emitting a smoother current. He noted that the tissues exposed to this current shrunk from dehydration. He named the effect as desiccation, when the tissues were destroyed in short of carbonization and dehydration. He was the first American to use this process frequently in order to remove the malignant growths of the skin, head, breast, neck and cervix using the device. Clark’s modification to the device lead to the development of an early version of the modern version instrument used to-day.

Bovie constructed an Electro-surgical Diathermy unit that produced high-frequency current delivered by a “Cutting Loop” to be used for cutting, Coagulation, and Desiccation. Technically, the usage of this apparatus was used to remove an enlarging Vascular Myeloma from

the head of a 64-year old patient in 1926 at Peter Bent Brigham Hospital in Boston. Prior to the discovery and usage of electrosurgical apparatus, Cushing failed to remove the mass because of the Vascularity.

After the success of this operation on such tumour by using his apparatus, he attempted to do many complex operations without Electrosurgical Technology. Surprisingly, Cushing's operative mortality increased due to the complex procedures.

BASIC IN PHYSICS

Electrosurgery: It is defined as passage of high-frequency electrical current through tissue to create a desired clinical effect.

It differs from Electro-cautery, where the electrical current is used to heat an instrument and the heated instrument is applied to the tissues to produce clinical effect. Whereas, in electro-surgery the current itself passed through to heat the tissues.

Circuit is an un-interrupted pathway of flowing electrons.

Ohm's Law: It describes the actions of a given circuit.

$$\text{Voltage} = \text{Current} \times \text{Resistance}$$

Current: It is measured as the flow of electrons during a particular period of time. It is measured in Ampere.

Voltage: The force which drives a current in the circuit against the resistance of the circuit. It is measured in Volt.

Power: It is defined as the capacity to do work per unit time and it is measured in Watt.

In Electro-surgery, the generator generates the voltage to produce current which is passed through the electrode tip to reach the tissues.

Human tissues are resistant to current. Higher resistance is directly proportional to higher voltage. The higher resistance needs greater voltage for the current to pass through. While using diathermy more superficial tissues are cauterized, where the dead tissue becomes less electrically conductive and makes them more resistant.

Electric Current usually travels the path of least resistance. A current can be driven in a circuit by electrons when acted on by an electric field.

In an incomplete circuit, the current has tendency to reach the ground. Earlier versions of electrosurgical generators were “ground referenced”, i.e., the flow of energy was in relation to earth ground.

Whenever there is a current flow, it would choose the path of least resistance. Because of this property, there may be an occurrence of current flow through an electrocardiogram pad or through an intravenous pole in contact with the patient. This in turn causes the possibility for a patient burn if the current density is high. In order to avoid, these complications, modern version of electro-surgical generators separated from ground, confining the current flow to the circuit between the electrode and the patient return electrode, which offers a low-resistance pathway for current to return to the generator from the patient.

D' Arsonval observed the body temperature rise when electricity is passed. It is due to the function of the current density.

$$\textbf{Energy} = \frac{\text{Current}}{\text{Cross-sectional Area}} \times \text{Resistance} \times \text{Time}$$

Joules Law states that energy produced is directly proportional to current density.

The effectiveness of energy conversion into heat is inversely related to the area of contact, the applying electrode is designed in such a way it is small and generate heat efficiently and returning electrode are designed as large to disperse energy.

The amount of thermal energy and the time-span of delivery will decide the Tissue Effects. Tissue thermal damage is reversible below 45°C. Tissue losses their structural Integrity and Proteins in the tissue become denatured, as tissue temperatures exceed 45°C. Above 90°C, the desiccation occurs, if the tissue is heated slowly or vaporization if the heat is delivered rapidly due to the liquid in the tissue evaporates. Around 200°C, the remaining solid components of the tissue are reduced to Carbon.

Electro-surgical generators generate energy that can be used as monopolar or Bipolar fashion.

The heat generated is dependent on four factors.

1. Size of Contact Area

2. Frequency of Current

3. Continuous or Intermittent Wave Form

4. Length of Activation Time.

COMMON ELECTRO-SURGICAL MODALITIES

MONOPOLAR DIATHERMY

The monopolar diathermy forms a complete circuit. In monopolar diathermy generator producing an alternating current is passed to the patient through active electrode and then return back to the neutral pole of generator through, tissue and return electrode. The return electrode have larger surface area than active electrode which has smaller surface area.

Figure 1 :
MONOPOLAR DIATHERMY

BIPOLAR DIATHERMY

In Bipolar Diathermy the two active Electrodes are nothing, but they are pair of diathermy forceps. Since both the limbs are active current flows only when the tissue is holding between the forces gets heated.

Fig.2 :
BIPOLAR DIATHERMY

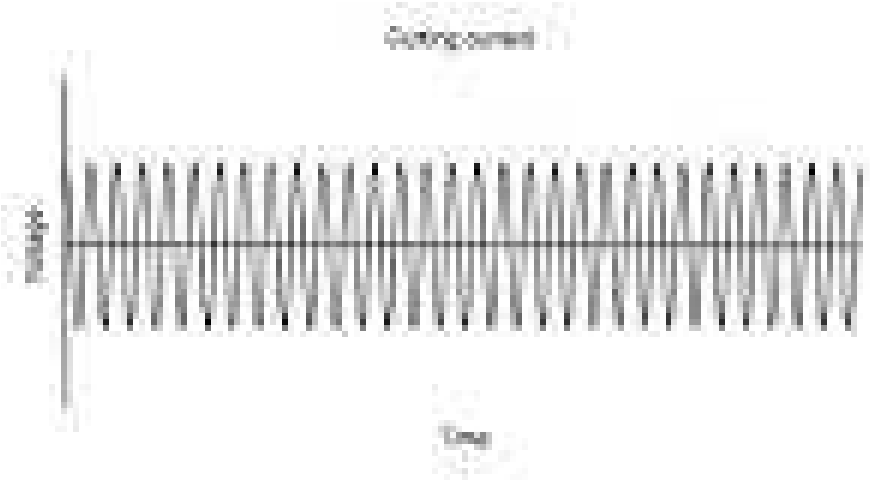
The output current from the electro-surgical generators delivers different waveforms to the tissue, depending on the mode fixed. The tissue effect depends on the waveforms. Whenever there is a change in the output waveforms it reflects a change in tissue effect.

Electro-surgical generators deliver current in two modes :

1. Continuous mode
2. Interrupted mode

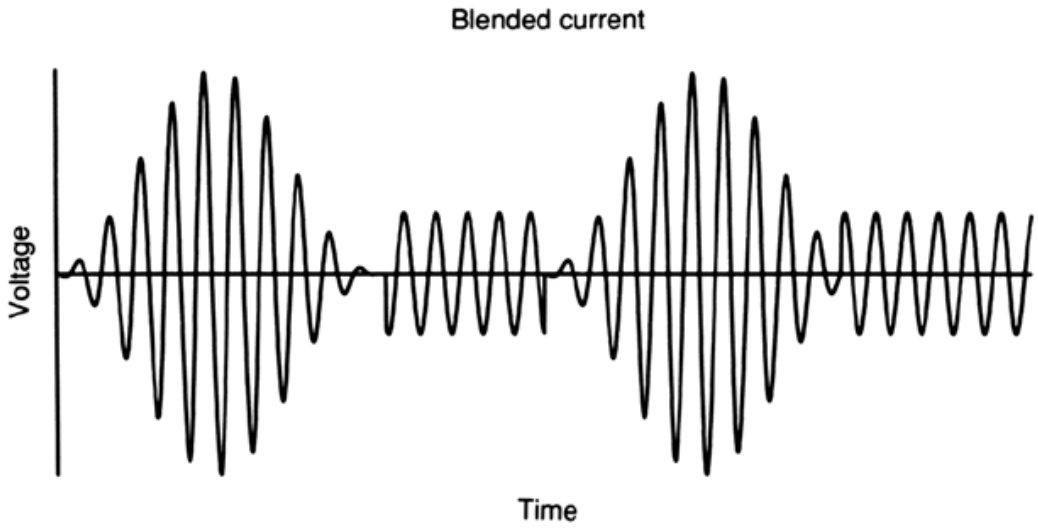
The continuous mode or “cut” mode is the current generated from generator in a continuous sinusoidal wave form.

Fig.3 :
CONTINUOUS MODE



The interrupted mode is also known as “*coag*” or coagulation mode. In interrupted mode, the current generated from the generator passed through the tissue approximately 6% of the time. The output voltage is higher, so that the same amount of power is delivered in both continuous and interrupted mode.

Fig. 4
INTERRUPTED MODE

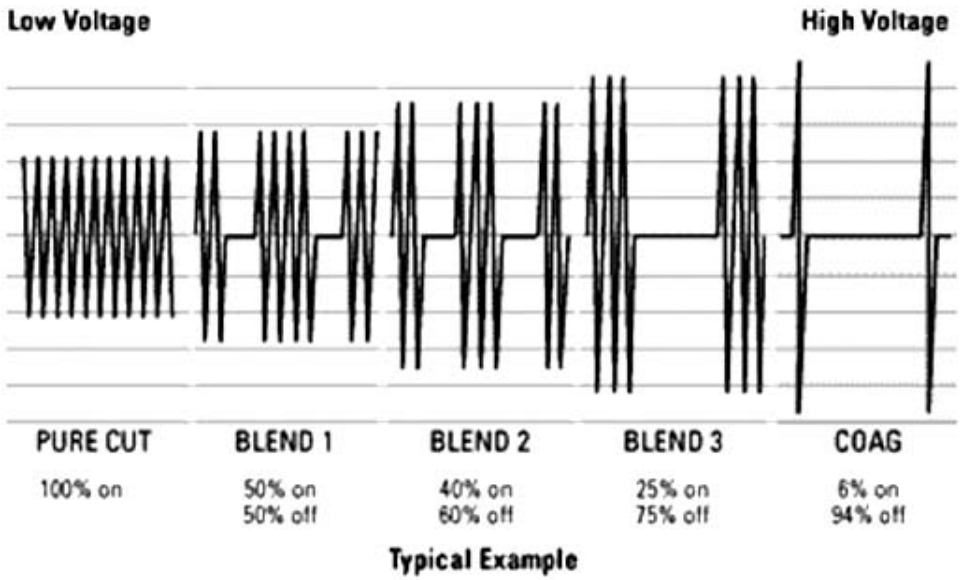


A modern electrosurgical generator generates various range of electrical waveform. blended modes that modify the degree of current interruption (so-called duty cycle), so that it cause varying degrees of cutting with hemostasis.

If the current flows through the tissue for less time in the interrupted or “coag” mode, tissue doesn’t get heated to the level of vaporization. As a result of less heat production, temperature of the tissue rises more slowly forming a coagulum and no vaporization occurs.

In “cut” mode, the continuous flow of current, increases the temperature of the when sufficient heat is produced the water in the cell explode into steam.

Fig. 5
INTERRUPTED MODE



If the surface area of the electrode is smaller, then current concentration is higher which can be subjected to the tissue in which it applied. This technique with low power setting gives us the desired surgical tissue effect. Longer the activation of the generator, more heat produced in the tissue. This may result in the heat or thermal spread to the adjacent tissues.

Tissue effects that occur while using diathermy are divided into three basic groups :

1. Coagulation

2. Fulguration

3. Cutting

In coagulation, heating causes the cell death by dehydration and protein denaturation. Haemostasis occurred due to distortion of the wall of the blood vessel, coagulation of plasma proteins, dried and shrunken dead tissue and stimulation of clotting mechanism.

In fulguration, the diathermy setting is same as for coagulation, but at higher voltage and because of higher voltage it cause sparks and fill the air gaps thus fulgurating the tissue.

Cutting occurs when the current is in continuous wave form. It can cut the tissue when the active electrode is held at very short distance. The electric discharge from the active electrodes are across the gap creating series of sparks which provides high temperature need for cutting.

ELECTRO-SURGICAL ENERGY GENERATORS (ESG)

Two types of electro-surgical generators :

1. Ground reference generators

2. Isolated generators

Ground-referenced Generators: The current produced by the generators pass through the tissue go to any grounded object like the pad ECG electrodes, operation table, metal objects and cause alternate site burns. Ground referenced generators are now obsolete or out dated.

Isolated Generators: These modern generators set apart the current from ground and do not allow the current to travel an alternative

Fig. 6
ISOLATED GENERATORS

path to the ground. The current that passes through the body must return through the dispersive pad which is in direct contact with the body to the generator.

TECHNIQUES OF DELIVERY

There are two types of basic electrical circuits:

1) monopolar and 2) bipolar.

MONOPOLAR

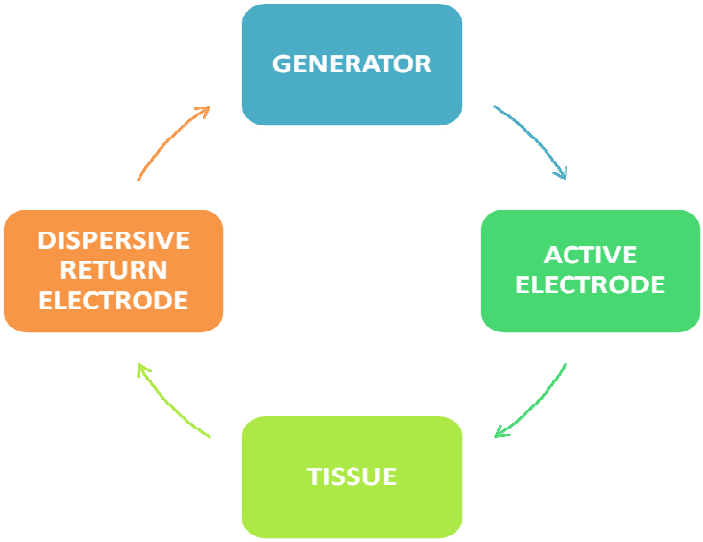
In monopolar device the high frequency alternating current is produced by generator. It composed of generator, electrode for application and electrode for return current thereby it completes the circuit.

There are now many inbuilt safety mechanism Return Electrode Monitoring (REM) / Contact Quality Monitor (CQM) to prevent this complication. The patients return plate pads are split and electrosurgical device through impedance measurement between the Two (split pad) can sense the contact area. When extreme variations or very high/ low

impedance appears, the CQM will lead to an alarm and can lead to deactivation of the output energy to prevent patient injury.

Most ESUs have two outputs labeled cut and coagulation (or “coag”). As explained earlier, these terms do not accurately reflect the appropriate tissue effect (Cutting, Coagulation or Desiccation and Fulguration) and use of the energy. Also there are no standards and the power and duty cycle can vary from one manufacturer to other. In addition, a third modulated version popularly known as “blend” also exists. “Blended” outputs are interrupted (or) modulated versions of the continuous or pure “cut” waveforms. When the current is interrupted, and therefore reduced, while the wattage is held constant, the generator increases the voltage of the output ($W = V \times I$).

Fig. 7

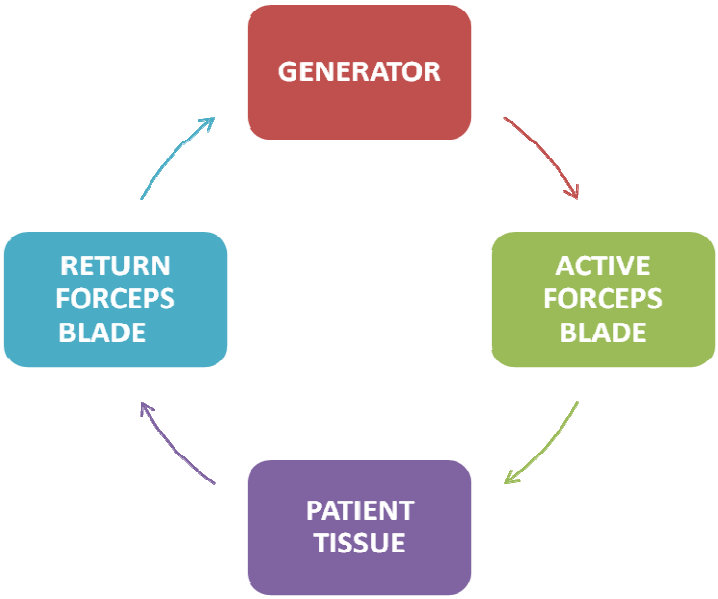


The Surgeon by manipulating the ESU output, area of contact and distance of the electrode from the tissue can get desired appropriate tissue effect (cutting, coagulation or desiccation and fulguration).

BIPOLAR

Bipolar is an electrosurgical device in which the current passes between which are placed across the tissue to be subjected. The main difference between the monopolar and bipolar is, No patient return electrode is needed in bipolar because it couldn't carry current hence the resistance increase. As the resistance increase the current flow decrease. However, bipolar systems also have limitations, as it is more difficult to

Fig.8

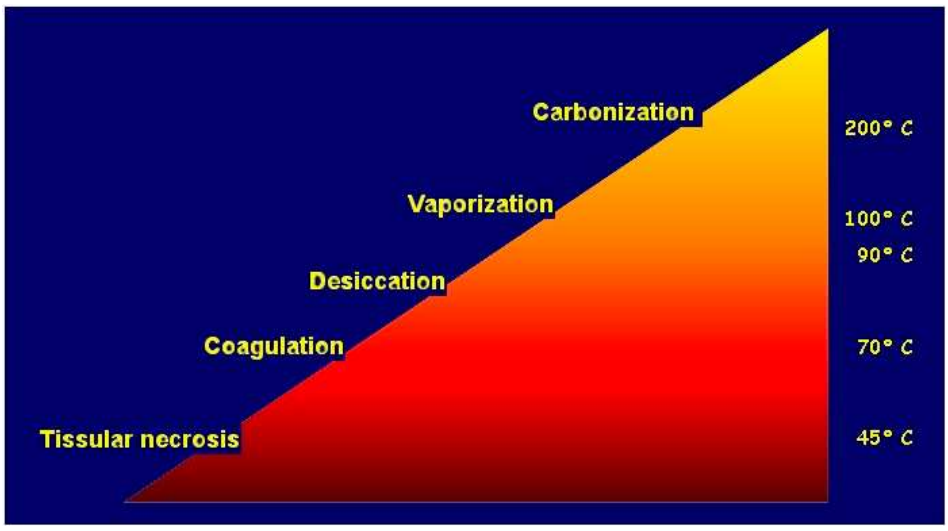


include a method for electrosurgical vaporization and cutting into the design. Most modern generators provide only a continuous wave form th e bipolar outlets that are identical to the “cut” waveform.

THERMAL ENERGY AND OBSERVED TISSUE EFFECT

TEMPERATURE	TISSUE EFFECT
< 45° C	Reversible Cell Damage
60° C	Cell Death
60°C - 90° C	White Coagulation and Desiccation
100° C	Vaporization
> 200° C	Carbonization “Black Coagulation”

Fig.9



Bipolar electrosurgical instruments used in the coagulation of tissue. The tissue is grasped between the tips of the instrument. The heat that is generated will affect only tissue and provides thermal coagulation

TISSUE EFFECT AND ELECTROSURCIAL GENERATOR OUTPUT

	Electro-surgical Cutting	**Electro-surgical Coagulation**	**Electro-surgical Fulguration**
Tissue Temperature	100^0C	60-95^0C	200^0C
Tissue Effect	Vaporization	White Coagulation	Black Coagulation
Best Achieved with	Cut Output	Cut Output	Coag Output
Electrode Position	Near contact	Contact	None or Near Contact
Electrode shape	Needle	Wider	Needle

ENERGY SOURCES USED IN SURGERY

- Laser
- Argon Beam Coagulator
- Photo-dynamic Therapy
- High- Frequency Sound Wave Techniques
- Harmonic Scalpel
- Ultrasonic Cavitation Devices
- Radio-frequency Ablation
- Cryoablation
- Microwave Ablation and Radio-Surgery

The addition of computer technology and development of microprocessors that can modulate current density, time and also pressure application over the tissues have revolutionized the electro surgery and have made them safer and more effective.

These systems measure local tissue impedance and/ or temperature in an attempt to more accurately define an “end point” of vessel sealing, based on the knowledge that certain temperature thresholds or high impedance levels are associated with complete tissue coagulation and desiccation.

They enable a surgeon to perform suture less vessel ligation and sealing of lymphatic channels upto 7mm in size.

RECENT USES

Electro-surgical instruments are very important to the surgeon

In earlier days, people believed that usage of diathermy devitalizes the tissues at the wound edges, leading to the post-operative infections.

In recent trends, there are number of literatures available to outcast the obsolete methods. In current trend, while using diathermy the heat is

not dispersed to the adjacent tissue but commonly dispersed as smoke. There are various studies to prove that electrosurgical incision can be as good as compared to scalpel incision.

Numerous studies proves that using diathermy have significantly less postoperative pain as compared to scalpel incision.

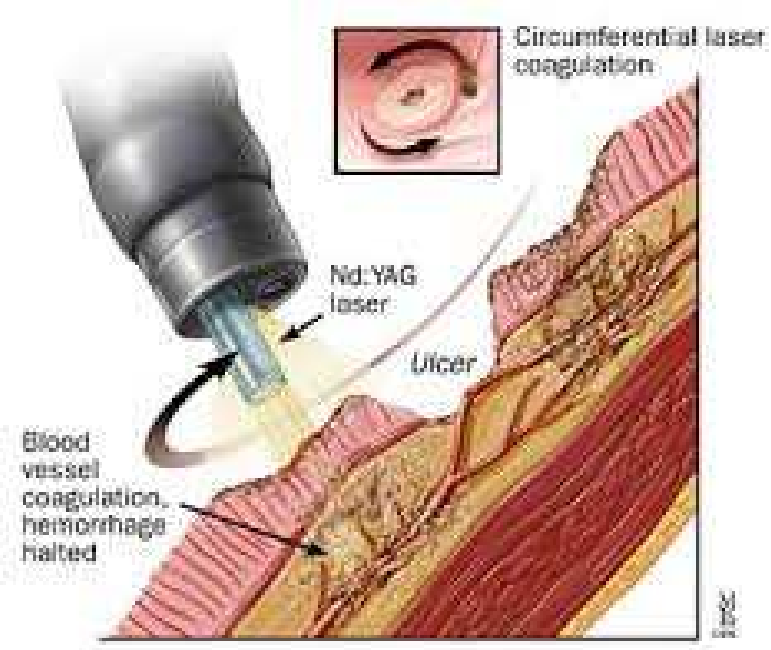
Devices using bipolar energy are available abundance in the market. Namely, harmonic scalpel which can seal the vessels in 4 to 7 mm diameter range, titanium clips, vascular staples are available in the modern surgical practice.

LASER

Laser use Photon to excite the molecular in the target tissue and produces kinetic energy that released as heat. The heat that is released causes protein denaturation and coagulation neurosis. The main advantage is that it can be applied to target tissue precisely and less adjacent tissue damage.

The commonly used types of laser are Argon, Carbon-di-oxide and Neodymium:Yttrium-Aluminium Garnet (Nd-YAG)

Fig.10
LASER



ARGON BEAM COAGULATOR

The Argon Beam Coagulator is a hand-held probe and the target tissue by establish a steady flow of electrons through a channel of electrically activated and ionized argon gas and completes electric circuit. This high-flow argon gas conducts electrical current to the target tissue and generates thermal coagulation of this tissue.

The depth of the thermal penetration of tissue varies from fractions of a millimeter to a maximum of 6mm depending on three factors:

1. Power setting
2. Distance between the Probe and the Target
3. Length of its application.

PHOTODYNAMIC THERAPY

Photodynamic therapy is recently developed treatment that allows destructions of cancer cells. First administer a target–specific photo-sensitizer that concentrated in the target tissue. The photosensitizing agent is activated with a wavelength–specific light energy source leads to the generation of free radicals cytotoxic to the target tissue. Photodynamic therapy has been used to treat different types of late – stage cancers.

HIGH FREQUENCY SOUND WAVE TECHNIQUES

High frequency setting, ultrasound can be used to dissect, cut and coagulate. Used in treating Cholelithilasis and Nephrolithiasis. The patient is placed in a water bath and a high energy acoustic shock wave is generated by piezoelectric. The water tissue interface allows the wave to pass through normal tissue without injuring it. The energy of the

shock wave is focused on the offending stone by ultrasound and causes disruption and fragmentation of the calculus, which is then passed via the ureter.

HARMONIC SCALPEL

The harmonic scalpel is an instrument that based on ultrasound to dissect tissue in bipolar fashion with only minimal tissue damage. It vibrates at a high frequency, approximately 55, 000 times / second, to cut tissue. The high frequency vibration of tissue molecules produce in the tissue, which in turn generates heat and denaturation of protein. It main advantage is to dissect tissue and coagulate small blood vessles all at once, with minimal energy transfer to surrounding tissue.

Fig.11
Harmonic Scalpel

ULTRASONIC CAVITATION DEVICES

The Cavitron ultrasonic surgical aspirator uses lower frequency ultrasound energy to fragment and dissect tissue of low fiber content. It is an ultrasound probe combined with aspirator, so it functions as an acoustic vibrator and sunction device at the same time.

This instrument fragments and aspirates tissue of low collagen and high water content, especially in liver and pancreatic procedures.

RADIO-FREQUENCY ABLATION

Radio-frequency energy used for tissue ablation in a curative or a palliative treatment. The basic of radiofrequency application is to place an electrode into the target tissue to transmit a high- frequency alternating current to the tissue in the range of 350 to 500 kHz. Rapid alternating directional movement of ions results in the release of kinetic energy.

Fig.12
Radio-Frequency Ablation

The raise of temperature of the target tissue to higher than 100 °c that cause protein de-naturation, desiccation, and coagulation necrosis

CRYOABLATION

Cryotherapy destroys cells by freezing and thawing. With liquid nitrogen or argon circulation through a probe placed over of within the target lesion, the tissue can be frozen to a temperature of - 35°C or lower. Cell damage occurs as a result of disruption of sub-celluar structures, with ice crystal formation in the freezing phase and degradation during the thawing process. Ischemia of the tissue from focal disruption of the circulation, shifting of water and electrolyte content in situ, and protein

denaturation also contribute to the tisse damage induced by cryotherapy. Lessions that contact major vessels can be difficult to treat with this modality.

MICROWAVE ABLATION AND RADIOSURGERY

Microwave coagulation is achieved by using a generator to transmit microwave energy at a frequency of 2450 MHz via a probe placed under image guidance within target organs or tissue. A rapidly alternating electrical field is created in the target tissue to induce motion of polar molecules in the tissue, such as water.

Kinetic energy is dissipated as heat, and causes coagulation necrosis. The major limiting factor is that the area that ablated with the current equipment is very small, thus requires multiple insertions of the microwave probe to treat a single lesion.

Vessel sealing with electro surgery are used in various surgical procedures.

LIGASURE

Ligasure system is a new technology that involves advanced monopolar technology uses body's own collagen and elastin to both seal and divide. This instrument monitors tissue impedance and provides real time adjustment of the energy delivered. Ligasure can seal vessels upto 7mm diameter with average seal time of 2 to 4 seconds.

Fig.13
Ligasure

Ligasure electro-surgical vessel sealing are used in thyroidectomy and hapatectomy.

ADVERSE EVENTS WHILE USING DIATHERMY

The use of electro-surgical devices in surgery is not possible without complication.

Monopolar electro-surgery usage in patients with implantable cardio version devices is potential for current concentrations. While using monopolar in patients with prosthetic devices, the operation must be done very carefully.

Fig.14
Return Electrode Pad

Usually the current will seek the direct pathway to the ground rather than returning via dispersive electrode which is placed away from the prosthetic device, so that it produces diathermy burns.

Diathermy burns mainly occurs due to the insulation failure. Surgeons must know how to use diathermy. It is best to prevent contact with nearby instruments while using diathermy. In case of insulation failure the current can pass through the leak joints to the nearby surface.

When the current flows through the active electrode and in direct contact with a metal instrument which is placed outside the body, coupling occurs while the current is being delivered.

In coupling, the energy is transferred from one instrument to another instrument. Which may accidentally contacts with the patient's body, it is outside the field of view. If this happens, it may cause damage to the area where the contact took place.

Capacitance coupling occur in which a capacitor is created by having insulator sand witched between two metal electrodes. An electric field is created around the capacitor which induces current flow in the cannula. Sparks from the diathermy can ignite any volatile or inflammable gas or fluid, Alcohol based skin preparation can catch fire.

When there is an improper grounding, offsite burns occur i.e., outside the area of the dispersive area

Diathermy injuries not only affects the patients but also affects the surgeon. When Surgical gloves are wet and the gloves becomes a conductive and causes burns.

CONSIDERATIONS IN SURGERY

It is important for a surgeon to understand these principles and modify it for optimum desired results with minimal collateral damage. Few important considerations that a surgeon must understand are discussed below.

ELECTROSURGICAL GENERATOR POWER OUTPUT:

Different generator brands have different output characteristics with varying peak voltages and variable duty cycles at the blend settings. In most instances, the appropriate power output for cutting will be the minimum amount necessary to and coagulation.

The surgeon should try to work and set appropriate power levels for the machine and store these data for future use. When more voltage is needed (for example when hemostasis is necessary along an incision line

or when transecting tissue that has relatively high impedance), one can use blended waveforms, where voltage may be incrementally increased without changing the power settings.

LOW-VOLTAGE CONTINUOUS OR MODULATED (CUTTING) MODE

The low-voltage continuous outputs are generally the most efficient and effective for either cutting (linear vaporization) or for coagulation/ desiccation(both contact and coaptive coagulation). The neonatal surgeon when using monopolar instruments for coaptive coagulation in both open and minimally invasive surgery must select cut setting when sealing blood vessels.

ELECTRODE SURFACE AREA

The power density required for vaporizing or cutting tissue is very high, which in turn requires the use of an electrode with a very small surface area. So with same power and mode of ESU, needle electrode can lead to vaporization whereas wider blade can lead to coagulation.

USE BIPOLAR ELECTROSURGERY

WHEN APPROPRIATE

Bipolar because of its low voltage is safer for in comparison to monopolar. The newer advanced bipolar instrument are excellent for vessel sealing especially in laparoscopy or thoracoscopy. The open surgery instruments with its capacity to seal 7mm vessels can reduce the use of sutures, which is likely to lead to less adhesion in abdomen. However its use is limited in minimally invasive surgery in neonates by the diameter of delivery probes (smallest is 5mm)

TISSUE IMPEDANCE OR RESISTANCE

Tissue such as bone, calloused skin, fat, or any previously desiccated tissue will impede passages of current and therefore will inhibit the creation of an electrosurgical effect. In these areas if it is necessary to cut through tissue (for example pelvic osteotomy in bladder exstrophy in neonates), One can increase the voltage by raising the power output or decreasing the duty cycle; both are equally effective.

ELECTRODE TIP

It is very important to clean the Electrode Tip. Impedance increases as the Eschar forms at the tip of the electrode. The Eschar should not be wiped by scratch pad. If scratched with pad groves in the Electrode Tip destroyed and further increase the Eschar build-up.

COMPRESSED TISSUE VOLUME

The larger the tissue thickness between the jaws of an electrosurgical instrument, regardless whether it is monopolar or bipolar, the greater the number of joules of energy that will be required for complete coagulation and desiccation.

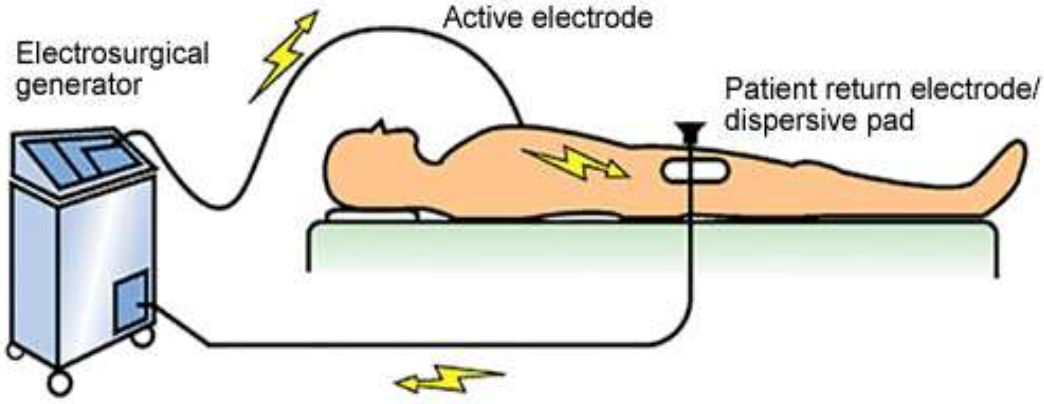
What this means is that thicker pedicles will result in more lateral extension of the electrosurgical thermal injury, a factor that may be enhanced with monopolar instruments.

So it is advisable that only minimal needed tissue or vessel should be taken between jaws of electrosurgical instruments.

THE PATIENT PLATE SHOULD BE PROPERLY GROUNDED

The patient plate should be placed at faraway as possible so that path of the current should not pass through the heart. Heart rate monitoring should be done throughout the procedure and defibrillator should kept aside as patient may develop dysrythimia at any time.

Fig.15



Liquids, such as skin preparation solutions, must not be allowed to pool around or leak under the patient plate. These can cause skin burn because the energy flowing towards the neutral electrode can pass through the conducting fluid bridge with a low electrical resistance. This can lead to a high concentration of current density at these points and hence to burning. This is more relevant in neonatal surgery where the

operative field and dispersive plate are likely to be adjacent to each other because of smaller patient size.

ELECTRORSURGICAL INJURIES TO THE SUREGEON

Surgical gloves are believed to protect surgeon by providing insulation from radiofrequency current. While using a Electrosurgical device the surgeon should be careful because faulty insulation of the device or cracked insulation or damage to gloves. In such times surgeon may have electric shock.

THE PRACTICE OF IMPROVISATION

To insulate the tip of the electrode as is often required in fine operations and while operating on can also prove dangerous. Sparks can when there is a small gap between these two electrode contact. Temperature of the electrosurgical active electrode is very high that melt the catheter. Insulated electrodes are designed with only exposed tips should be used instead.

ADVANTAGES OVER ELECTROSURICAL INSTRUMENTS

Ultrasonic surgical devices have proved that they provide that they provide efficient transection, good hemostasis, minimal lateral thermal damage, low smoke generation and more important is no risk of electrical current passage to the patient. Ultrasonic mechanism can cut through thicker tissue, creates less and safer smoke and may offer greater precision. Tissue damage and wound complications are also reported to be low when compared with electrocautery.

The harmonic scalpel is not as easy as compared to diathermy to use, Harmonic scalpel only coagulates as it cuts but surgical diathermy can coagulate bleeding tissue at any time and this is the disadvantage of harmonic scalpel.

CONSIDERATIONS IN SURGERY

WHILE USING ULTRASONIC DEVISES

Minimal access surgery in the neonate is an emerging field that has greatly increased its scope in the last decade. Due to space constraints in a neonate use of energy sources that produce less collateral damage and injury to organs due would be preferable. Since electric current does not pass through the neonate, hence it is far safer than electro-cautery. Even in open surgeries like taking down vessels in mesentery becomes quite easy and fast with ultrasonic devices. Although no electrical current passes, the instrument tip can become quite hot, leading to chances of direct thermal damage to adjacent tissues in small neonatal area of operation.

FUTURE DIRECTIONS

Active research in electrosurgery and its applications is going on. Modern electrosurgical generators use closed-loop control loops to adjust the voltage and current so that to maintain output power constant as the active monopolar electrode moves through tissues of varying impedance. This can become possible because of adaptive

generators which adopts according to the needs.

In modern electrosurgical generators computer chip can be inserted to modify the functions according to the desired clinical effect.

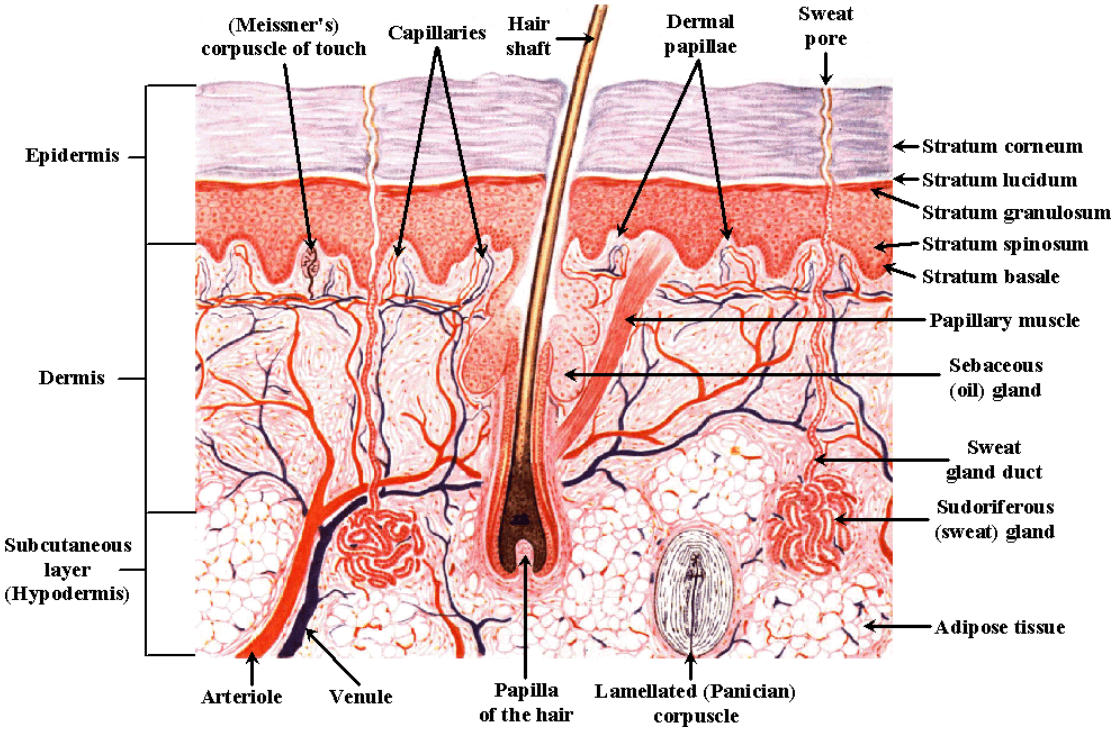
In near future margins of the defect can be closed using new technique called fusing alloderm.\

The Surgeon should know all basic principles behind electrosurgery remains most important. For tissue interaction biophysical aspects should be thoroughly understood. For improved patient outcomes we should thoroughly understood the technology and it’s applications.

LAYERS OF SKIN

The skin covering consist of the skin (cutis) and subcutis, specific structures in the skin include the cutaneous appendages- skin glands, hair and nails. The skin (cutis) consists of the epidermis, which is a stratified, cornified, squamous epithelium, and the corium, a layer of connective tissue.

Fig. 16
Layers of Skin



The corium contains the papillary layer, in which the papillae are interlocked with the epidermis, and a reticular layer, which gives the skin resistance against tearing.

The subcutis forms the connections with the structures, which lie beneath the skin, such as fascia and periosteum. It frequently contains fat. The major blood vessels and nerves of the skin lie in the subcuits.

The cells, which originate in the basal layer of the epidermis, undergo step by step transformation leading to their cornification and stratification in the epithelium. Ultimately the keratinized cells are shed from the outer surface of the epidermis. The migration of cells from the basement layer to the surface takes about 30 days.

There is a layer of regeneration, of formation of the keratin and a keratinized layer. The first two of these layers also contain other layers of cells. The stratification of the epidermis is best developed in glabrous skin (eccrine sweat glands, lamellar nerve endings) and is hardly developed at all in hairy skin (hair, sebaceous glands, and muscle to erect the hair, apocrine scent glands).

The arteries form a network between the cutis and the subcutis from which branches descend to the hair roots and the sweat glands; other branches ascend to the papillary bodies where they form a sub papillary plexus from which capillary loops penetrate into the papillae.

The skin is amply supplied with nerves, a small proportion of them is autonomic nerves, which supply the glands, but the majority are

sensory nerves. The nerves make the skin a vital and indispensable sense organ for the sensations of touch, pain and temperature.

A wound is a breach in the Continuity, of epithelium of skin or mucous mebrant. Wounds may be accidental, or infection or surgical. Wounding has a variety of effects on the tissues.

MECHANICAL

Separation of functional tissue structures with the creation of dead space, in which will gather blood clot and serous and fibrinous exudates. The divided blood vessels at the wound edge contract and thrombose at their cut ends under the action of platelets.

BIOLOGICAL

The primary cellular events seem to be strongly influenced by platelets in the thrombus, which are an important source of cytokines, the signals which determine subsequent events.

The cells adjacent to the wound margin up regulate a variety of genes, and there is proliferation of epithelial cells and fibroblasts within hours or days. Which migrate into the wound.

The phases of Healing are divided into Four events, i.e..

1. Coagulation
2. Inflammation
3. Fibroblasia
4. Re-Modelling

COAGULATION

Injury causes hemorrhage from damaged vessels and lymphatics. Vasoconstriction occurs immediately as a result of release of catecholamines. Various other vasoactive compounds, such as bradykinin, serotonin, and histamine, are released from tissue mast cells. They initiate the process of diapedesis, a passage of intravascular cells through vessel wall and into the extra vascular space of the wound.

Platelets derived from the hemorrhage form a haemostatic clot and release clotting factors to produce fibrin, which form a mesh for the further migration of inflammatory cells and fibroblasts. Fibrin is produced from fibrinogen, which is formed by the action of thrombin in the presence of thromboplastin.

INFLAMMATION

Within 24 hours the wound is predominated by polymorpho nuclear leukocytes, and then macro-phages which regulate the connective tissue matrix repair by cytokines.

FIBROPLASIA

The Fibrous protein collagen is synthesized, and the cross linking and deposition of collagen and other matrix proteins that provide the healed wound with strength and integrity.

REMODELING

Acute and chronic inflammatory cells diminish gradually, angiogenesis ceases, and fibroplasias ends. The equilibrium between collagen synthesis and collagen degradation is gradually restored. Normally a fibrous repair is imperfect, but functional and not excessive.

In a clean, incised wound there is little separation of tissue and approximation of the edges by sutures effectively approximates the margins, thereby minimizing the amount of cellular proliferation and migration necessary to bridge the defect, this type of wound healing called primary intention. Where a significant gap must be bridged

between margins, there is outgrowth of vascular granulation tissue from the raw wound edges, and this is the essential component of healing by Secondary intention.

The principles of selecting an incision are simple and include insurance of adequate exposure and good healing, an acceptable scar. An incision is properly planned as to shape, direction, and size. In general, incisions are made along the normal skin lines. In reoperations, every attempt should be made to use the original incision. Counter traction, if properly applied, allows the surgeon to make a clean, precise incision.

Skin incisions may be made with the stainless steel surgical scalpel, with care taken to ensure that the cutting edge does not drag or crush as it cuts9. Often incisions are made with the No 15 blade on a flat surface. Cutting with the tip of a blade makes it more difficult to control the depth of the incision. Incision of the skin made at an oblique angle may cause a trapdoor appearance. An incision should be ' beveled only to preserve the integrity of hair follicles.

Surgical lasers are multipurpose tools that can cut coagulate, vaporize tissue, weld and selectively destroy pigmented pathologic tissues. The CO_2 work by principles that causes instantaneous heating of

intra-cellular water to boiling, exploding cells in its pathway. It can cut tissues for some extent.

Laser works by principle that it generates steam and carbonization of tissues. The necrosis around the laser zone is <0.1 mm and it is superior in case of very large surgical incision.

The Laser used for surgery is. Ho : YAG Laser. It has a wave length of 2.1nm. Water can absorb this wave length. This is the only instrument that can vaporize, cut, coagulate, smooth, and sculpt tissue.

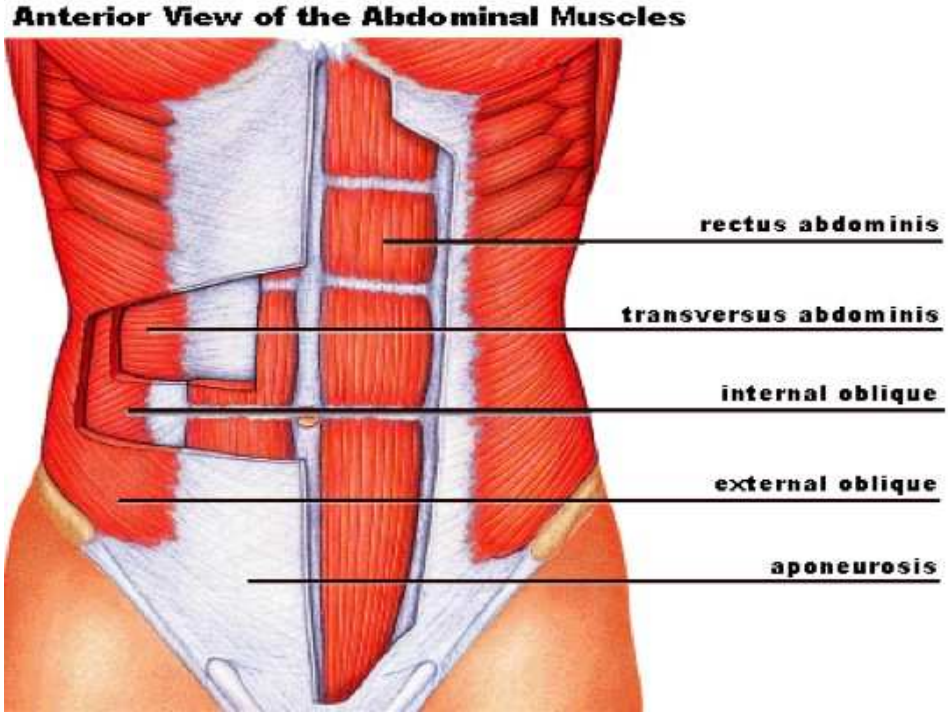
ABDOMEN

The abdomen is the region of the trunk that lies between the diaphragm above and inlet of pelvis below.

STRUCTURE OF ABDOMINAL WALL

Anteriorly: The abdominal wall is formed above by lower part of the thoracic cage Below by the rectus abdominis, external oblique, internal oblique, and transverses abdominis muscles and fasciae.

Fig.. 19



STRUCTURE OF ANT. ABDOMINAL WALL

It is made up of skin, superficial fascia, deep fascia, muscles, extraperitoneal fascia and parietal peritoneum . The abdominal walls are lined by a fascial envelope and the parietal peritoneum

SKIN

Natural lines of cleavage in the skin are constant and run almost horizontally around the trunk An incision along a cleavage line will heal as a narrow scar, while one that crosses the lines will heal as a wide scar.

Cutaneous Nerve Supply Is derived from the anterior rami of the lower six thoracic and first lumbar nerves . Thoracic nerves are the lower five intercostal and the subcostal nerves. First lumbar nerve is represented by the iliohypogastric and ilioinguinal nerves

BLOOD SUPPLY

Skin near the midline is supplied by branches of the superior epigastric artery (br. of int. thoracic artery) and the inferior epigastric artery (br. of external iliac artery) Skin of the flanks is supplied by branches from the intercostal, lumbar, and deep circumflex arteries

SUPERFICIAL FASCIA

Fatty layer or fascia of camper is continuous with the superficial fat over the rest of the body and may be extremely thick in obese patients .

The membranous layer or scarpa's fascia is thin and fades out laterally and above. Becomes continuous with the superficial fascia of the back and the thorax

SUPERFICIAL FASCIA

Inferiorly the membranous layer passes onto the front of the thigh, where it fuses with the deep fascia l. In the midline inferiorly forms a tubular sheath for the penis or clitoris.

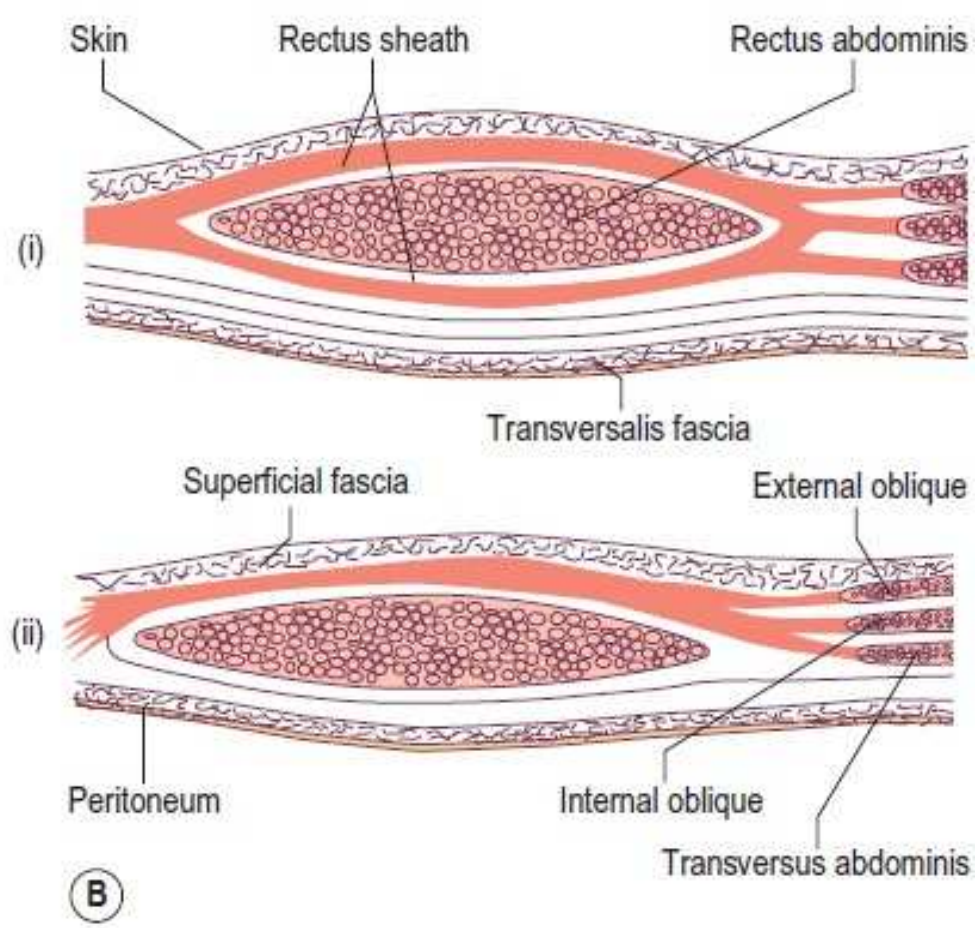
Below in the perineum, enters the wall of the scrotum or labia majora. From there it passes to be attached on each side to the margins of pubic arch, here it is called Colle's fascia

SUPERFICIAL FASCIA

Posteriorly it fuses with the perineal body and the margin of the perineal membrane. The fatty layer is represented as a smooth muscle in

the scrotum, the dartos muscle The membranous layer persists as a separate layer.

Fig.20



DEEP FASCIA

Deep fascia in the anterior abdominal wall is merely a thin layer of connective tissue covering the muscles. It lies immediately deep to the membranous layer of the superficial fascia

MUSCLES

Consist of three broad thin-sheets which are aponeurotic in front from exterior to interior. They are:

1. External oblique
2. Internal oblique, and
3. Transverse abdomins.

A wide vertical muscle, the rectus abdominis which lies on either side of the midline anteriorly

MUSCLES

As the aponeurosis of three sheets pass forward, they enclose the rectus abdominis to form the rectus sheath. The cremaster muscle which is derived from the lower fibers of internal oblique, passes inferiorly as a covering of the spermatic cord and enters scrotum

EXTERNAL OBLIQUE MUSCLE

It is a broad, thin, muscular sheet.

Origin: Lower 8 ribs Insertion: Xiphoid process, linea alba, pubic tubercle, iliac crest.

Nerve Supply: Lower 6 thoracic nerves, iliohypogastric & ilioinguinal nerves.

Action: Supports abdominal content, assists in forced expiration, micturition, defecation, parturition, vomiting

EXTERNAL OBLIQUE MUSCLE

A triangular shaped defect in the external oblique aponeurosis lies immediately above and medial to the pubic tubercle, known as superficial inguinal ring.

Between the anterosuperior iliac spine and the pubic tubercle, the lower border of the aponeurosis is folded backward on itself, forming the inguinal ligament

INTERNAL OBLIQUE MUSCLE

Origin: Lumbar fascia, Iliac Crest, Lateral two thirds of inguinal ligament.

Insertion: Lower three ribs and costal cartilages, xiphoid process, linea alba, and symphysis pubis.

Nerve Supply: Lower six thoracic nerves, iliohypogastric & ilioinguinal nerves.

Action: Supports abdominal contents, assist in forced expiration, micturition, defecation, parturition, vomiting

TRANSVERSUS ABDOMINIS

Origin: Lower six costal cartilages, lumbar fascia, iliac crest, lateral third of inguinal ligament Insertion: Xiphoid process, linea alba, symphysis pubis

Nerve Supply: Lower six thoracic nerves, iliohypogastric&ilioinguinal nerves.

Action: Compresses abdominal contents

RECTUS ABDOMINIS

Origin: Symphysis pubis and pubic crest Insertion: 5th, 6th and 7th costal cartilages and xiphoid process.

Nerve Supply: Lower six thoracic nerves

Action: Compresses abdominal contents, flexes vertebral column, accessory muscle of expiration

LYMPH DRAINAGE

Lymph drainage of the skin of the anterior abdominal wall above the umbilicus is upward to the anterior axillary (pectoral group of nodes).

Below the level of umbilicus drains downward and laterally to the superficial inguinal nodes . Swelling in the groin is may be due to enlarged superficial inguinal node

VENOUS DRAINAGE

Venous blood is collected into a network of veins that radiate from the umbilicus The network is drained above into the axillary vein via the lateral thoracic vein.

Below into the femoral vein via the superficial epigastric and the great saphenous veins Few small veins, the paraumbilical veins form a clinically important portal-system venous anastomosis

CAPUT MEDUSAE

The superficial veins around the umbilicus and the paraumbilical veins connecting them to the portal vein may become grossly distended in case of portal vein obstruction. The distended subcutaneous veins radiate out from the umbilicus, producing in severe cases the clinical picture called

CAPUT MEDUSAE

Nerves of the anterior abdominal wall supply the skin, muscles and the parietal peritoneum They are derived from the anterior rami of lower six thoracic and the first lumbar nerves.

Inflammation of parietal peritoneum causes pain in the overlying skin and also a reflex increase in tone of the abdominal musculature in the same area

RECTUS SHEATH

Is a long fibrous sheath Encloses the rectus abdominis and pyramidalis muscle (if present) Contains the anterior rami of lower six thoracic nerves and the superior and inferior epigastric vessels and lymph vessels Formed mainly by aponeurosis of three lateral abdominal muscles

For description it is considered at three levels: Above the costal margin the anterior wall is formed by the aponeurosis of the external oblique and posterior wall is formed by the thoracic wall. That is the 5th, 6th and 7th costal cartilages and the intercostal spaces

Between the costal margin and the level of the anterosuperior iliac

spine, the aponeurosis of the internal oblique splits to enclose the rectus muscle The external oblique aponeurosis is directed in front of the muscle Transversus aponeurosis is directed behind the muscle

Between the level of the anterosuperior iliac spine and the pubis, the aponeurosis of all three muscles form the anterior wall The posterior wall is absent The rectus muscle lies in contact with the fascia transversalis

The posterior wall of the rectus sheath is not attached to the rectus abdominis muscle. The anterior wall is firmly attached to it by the muscle's tendinous intersections

LINEA ALBA

The rectus sheath is separated from its fellow on the opposite side by a fibrous band called the linea alba Extends from the xiphoid process to the symphysis pubis.

METHODOLOGY

DATA SOURCES:

Every patients admitted in government Rajaji hospital in department of general surgery undergoing laparotomy in elective settings.

STUDY DESIGN:

This is an randomized control study in which the patients are divided into two groups based on the random number. The observer will be blinded to the type of incision used.

The surgeon will be informed about the type of incision using either scalpel or diathermy just before the surgery.

SAMPLE SIZE:

90 cases

DURATION :

1 year

AIM OF THE STUDY:

The aim of this study is to compare the efficacy and safety of surgical diathermy versus conventional scalpel incision for midline laparotomy.

PRIMARY OBJECTIVES:

To evaluate diathermy as an effective alternative to scalpel incision.

STUDY POPULATION

All patients undergo elective midline laparotomy during the period of study.

INCLUSION CRITERIA

All patients undergoing elective midline laparotomy of age >13 years are eligible for the study. Only clean and clean contaminated cases are included.

EXCLUSION CRITERIA

Patients who had previous mid-line laparotomy.

Those on anticoagulant and corticosteroid therapy were excluded from the study.

SELECTION OF PATIENTS TO UNDERGO DIATHERMY OR SCALPEL INCISION

All patients of age> 13 years include

Diabetic or Non-diabetic

Hypertensive or normo-tensive

Obese or non-obese

STUDY PROTOCOL

The patients included in the study are all who met the inclusion criteria after informed and written consent are enrolled in the study.

Randomized into two groups according to whether the diathermy or scalpel used in making skin incision.

The Surgeon was informed of the type of skin incision to be used just before the start of the skin incision.

INSTRUMENT USED

Coviden Force FX Electrosurgical Generator 8CS in Monopolar Cutting Mode (Blend) with power settings of 30 watts.

DESIGN OF STUDY

Prospective Study

PERIOD OF STUDY

1 Year

SELECTION OF STUDY SUBJECTS

All patients undergoing midline laparotomy of age greater than 13 years.

METHODS

Prospective randomized clinical study.

CONSENT :

Informed and written consent from all patients

ANALYSIS

Using CHI SQUARE test – ‘p’ value

STUDY VARIABLES

Study variables to be analyzed are :

1. Incisional Time,
2. Incision related blood-loss
3. Post-operative Pain
4. Post-operative wound complications.

INCISION TIME

The time from the start of the skin incision to completion of peritoneal incision with complete hemostasis was recorded

INCISIONAL BLOOD LOSS

Blood loss during skin incision was calculated by weighing the swab used exclusively in making the incision and during hemostasis with each gram taken as equal to one ml of blood (1 gm = 1 ml).

No suction evacuation of blood were done while making the skin incision. The length and depth of incision at the end of the procedure were measured in centimeter using sterile inch tape.

Incisional area was calculated as a product of the length and width of skin incision. The amount of blood was calculated as ml/cm2.

POST-OPERATIVE PAIN

Post-operative pain was assessed according to pain verbal rating scale (VRS).

No Pain	Mild Pain	Moderate Pain	Severe Pain
0	1	2	3

POST-OPERATIVE

WOUND COMPLICATION

Wound complication includes

1. Hematoma
2. Seroma
3. Wound infection
4. Wound dehiscence.

Wound infection was graded according to **Southampton Wound Grading System**

G1 Normal healing with mil- bruising or Erythema.

G2 Erythema plus other signs of Inflammation.

G3 Clear or Serosanguineous discharge.

G4 Purulent discharge

All patients were operated under GA/RA. Antibiotic prophylaxis was done using I.V cefotaxime at about 30 minutes prior to induction of anesthesia.

Subcutaneous tissue sutured using 2-0 chromic catgut. Skin sutured using 2-0 silk in vertical mattress.

Skin sutures were removed between 10 to 12 post- operative day ,after checking the tensile strength of wound by gradual lateral traction.

Wound left open for secondary healing were kept on daily dressing.

RESULTS

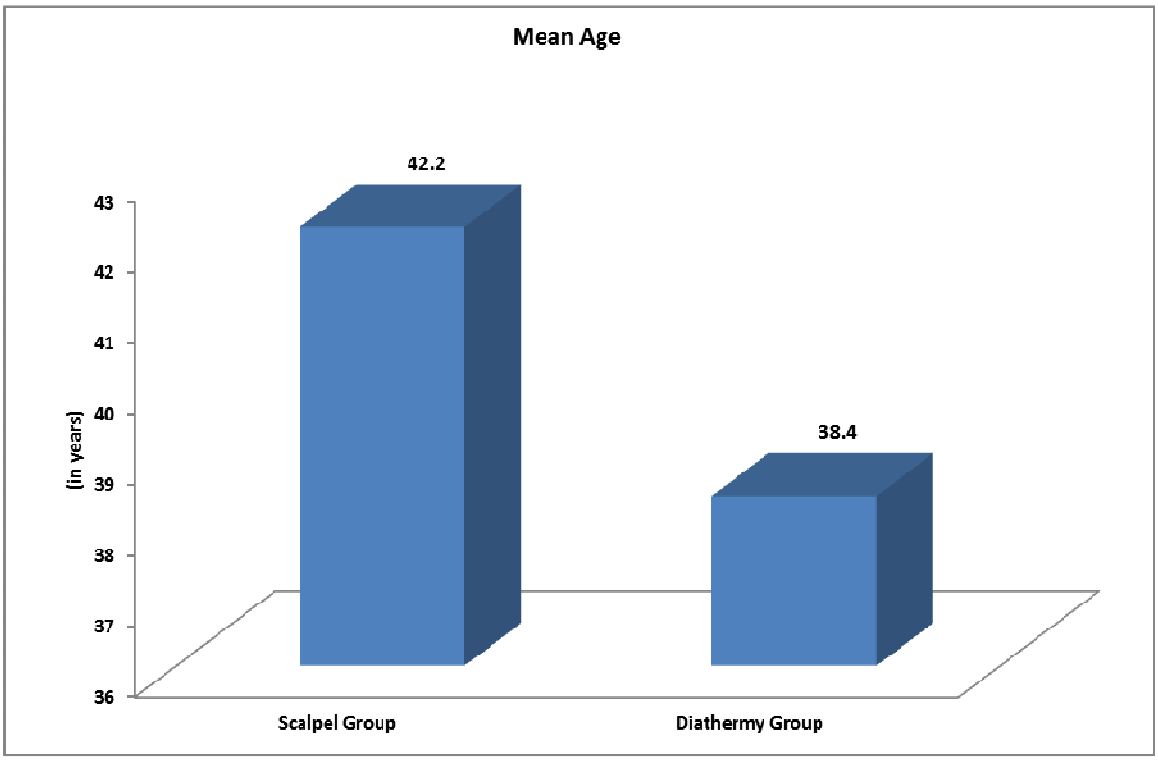
PATIENT DEMOGRAPH

90 patients are randomized prospectively to either scalpel group or diathermy group for skin incision .

Age (in yrs)	**Scalpel Group (N=45)**	**Diathermy Group (N=45)**
Mean ± SD	42.2 ± 11.4	38.4 ± 11.2
Min, Max	23, 62	19, 68
P - Value	0.118	

The mean age of patients in scalpel group is 42.2 ± 11.4 and in diathermy group is 38.4 ± 11.2

Fig. 21
Patient Age Group



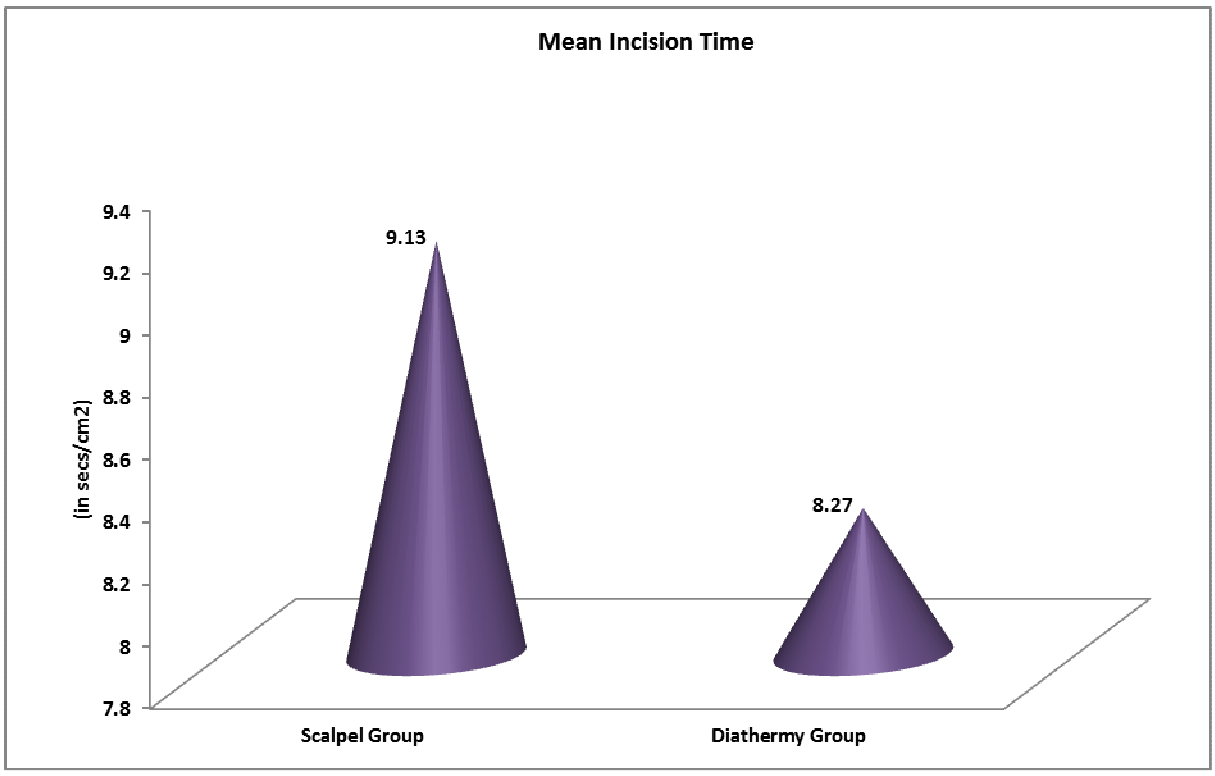
There were no significant differences between two groups with respect to patient demography.

INCISION TIME

Incision Time (Secs/Cm^2)	**Scalpel Group**	**Diathermy Group**
Mean ± SD	9.13 ± 0.37	8.27 ± 0.34
Min, Max	7.52, 9.52	7.48, 9.02
'P' value	**< 0.001**	

The mean incision time in scalpel group is 9.13 ± 0.37 and the mean incision time in diathermy group is 8.27 ± 0.34

Fig. 22
Incision Time



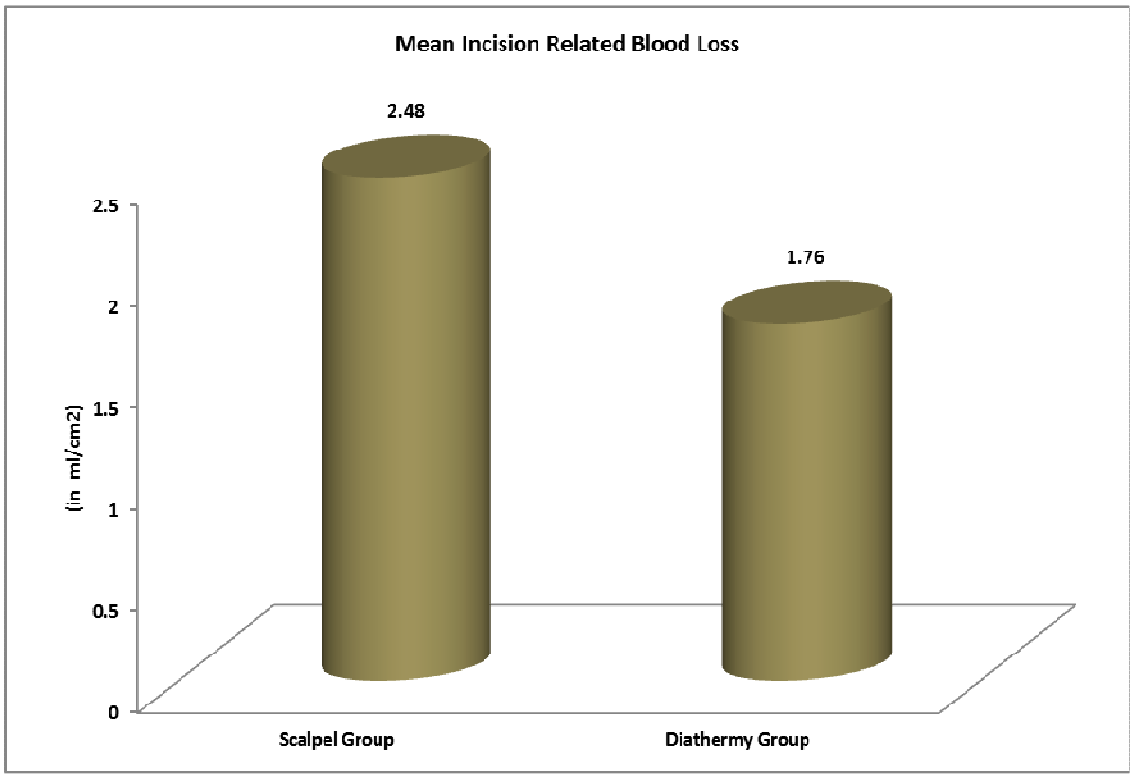
The incision time is less in diathermy group when compared to scalpel group P- value is <0.001, it denotes that there is a significant difference between two groups.

INCISION RELATED BLOOD LOSS

Incision Related Blood Loss (ml/cm2)	Scalpel Group	Diathermy Group
Mean ± SD	2.48 ± 0.29	1.76 ± 0.14
Min, Max	1.7, 2.9	1.5, 2.0
'P' value	**< 0.001**	

The mean value of scalpel group is 2.48 ± 0.29 and the mean value of diathermy group is 1.76 ± 0.14

Fig. 23
Incision Related Blood Loss



Since the 'P' value is less than .001 there is a significant difference between diathermy and scalpel group.

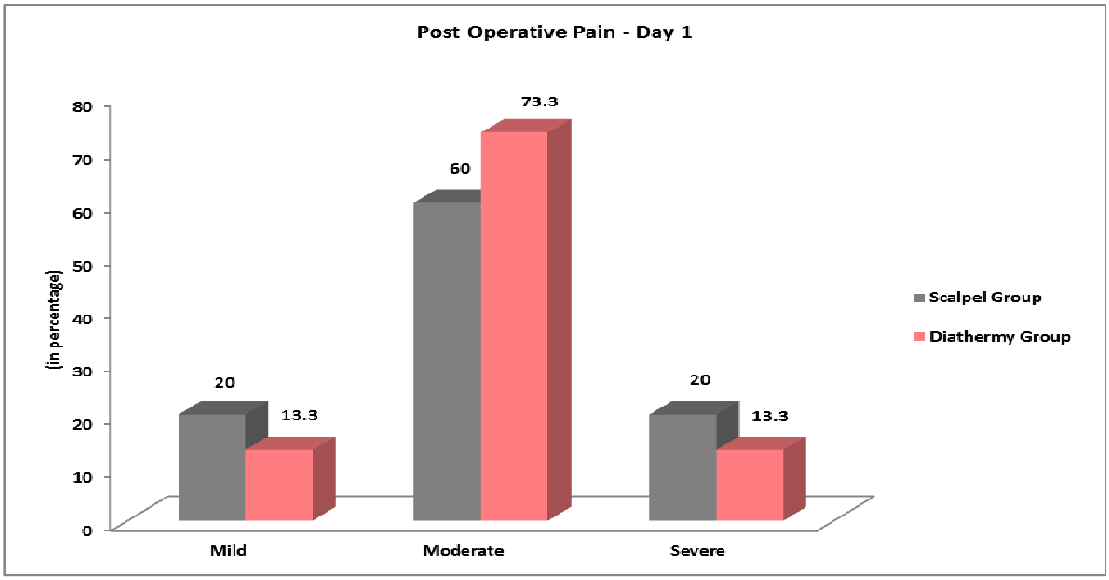
POST-OPERATIVE PAIN

DAY - 1

Post-operative pain is assessed by means of verbal rating scale (VRS) up to fifth post-operative day.

Pain Score – Day1	**Scalpel Group (N=45)**	**Diathermy Group (N=45)**
Mild	9 (20.0%)	6 (13.3%)
Moderate	27 (60.0%)	33 (73.3%)
Severe	9 (20.0%)	6 (13.3%)
'P' value	**0.407**	

Fig. 24
Post-Operative Pain



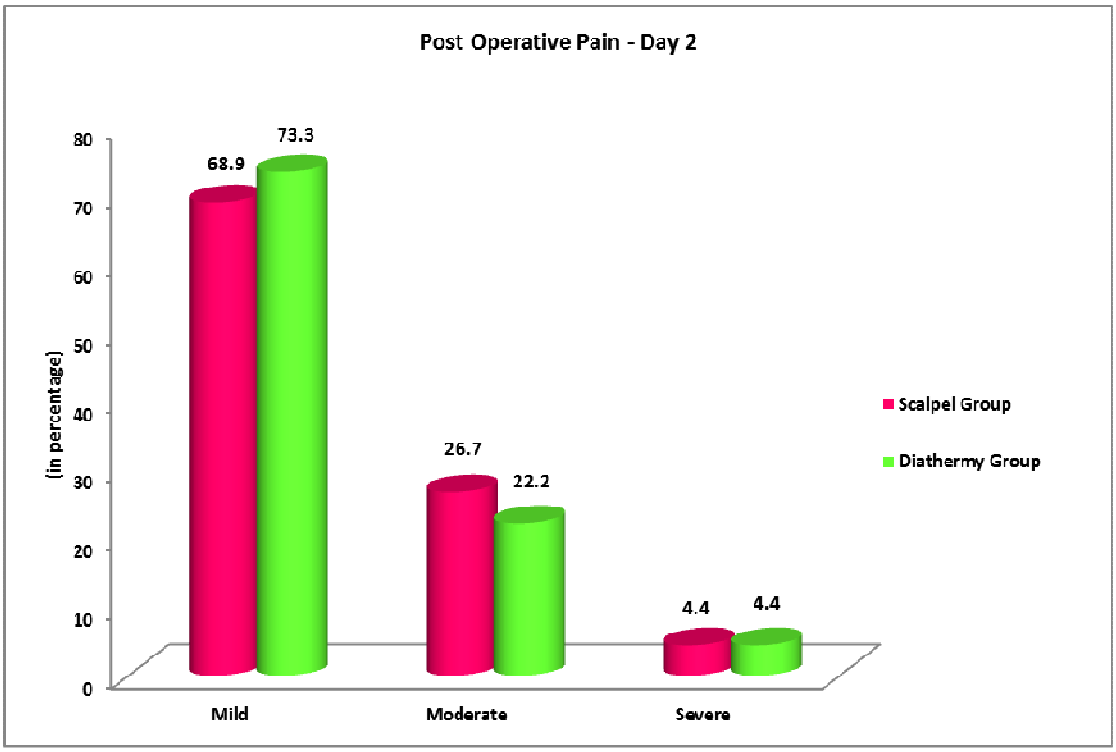
POST-OPERATIVE PAIN

DAY -2

Post-operative pain was treated by injection Diclofenac 50mg intra-muscular will be given.

Pain Score Day2	**Scalpel Group (N=45)**	**Diathermy Group (N=45)**
Mild	31 (68.9%)	33 (73.3%)
Moderate	12 (26.7%)	10 (22.2%)
Severe	2 (4.4%)	2 (4.4%)
'P' value	**0.885**	

Fig.25



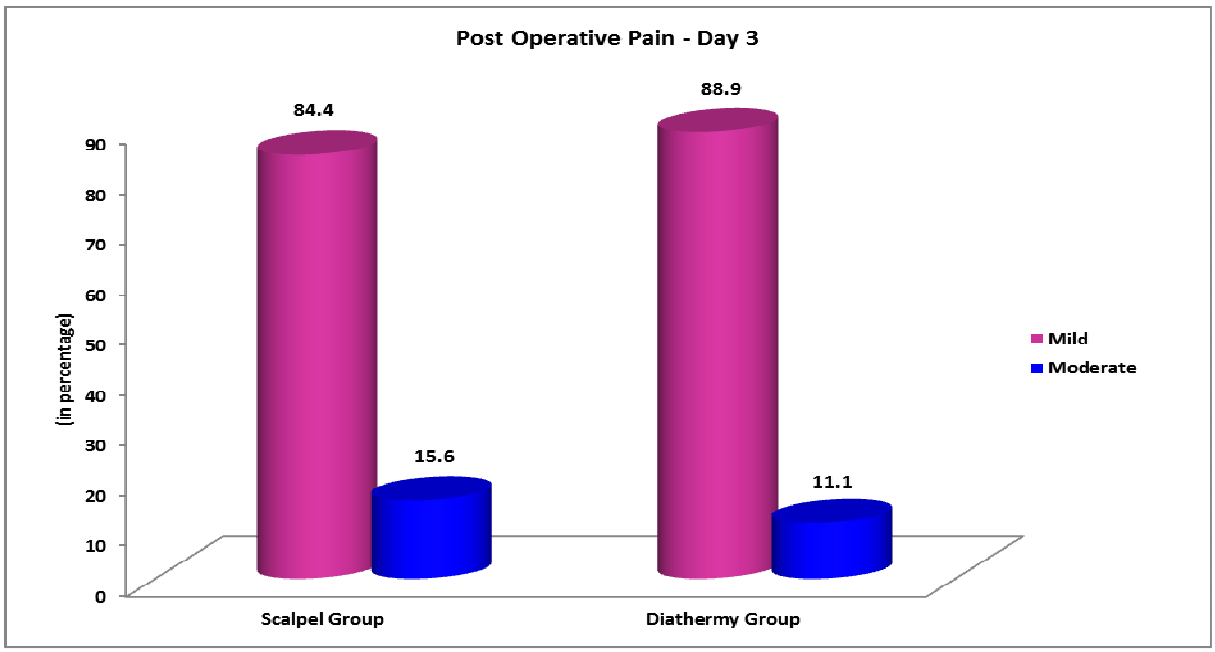
In second post-operative period patient have only mild pain in both diathermy and scalpel groups.

POST-OPERATIVE PAIN

DAY - 3

Pain Score Day3	**Scalpel Group (N=45)**	**Diathermy Group (N=45)**
Mild	38 (84.4%)	40 (88.9%)
Moderate	7 (15.6%)	5 (11.1%)
'P' value	**0.535**	

Fig. 26



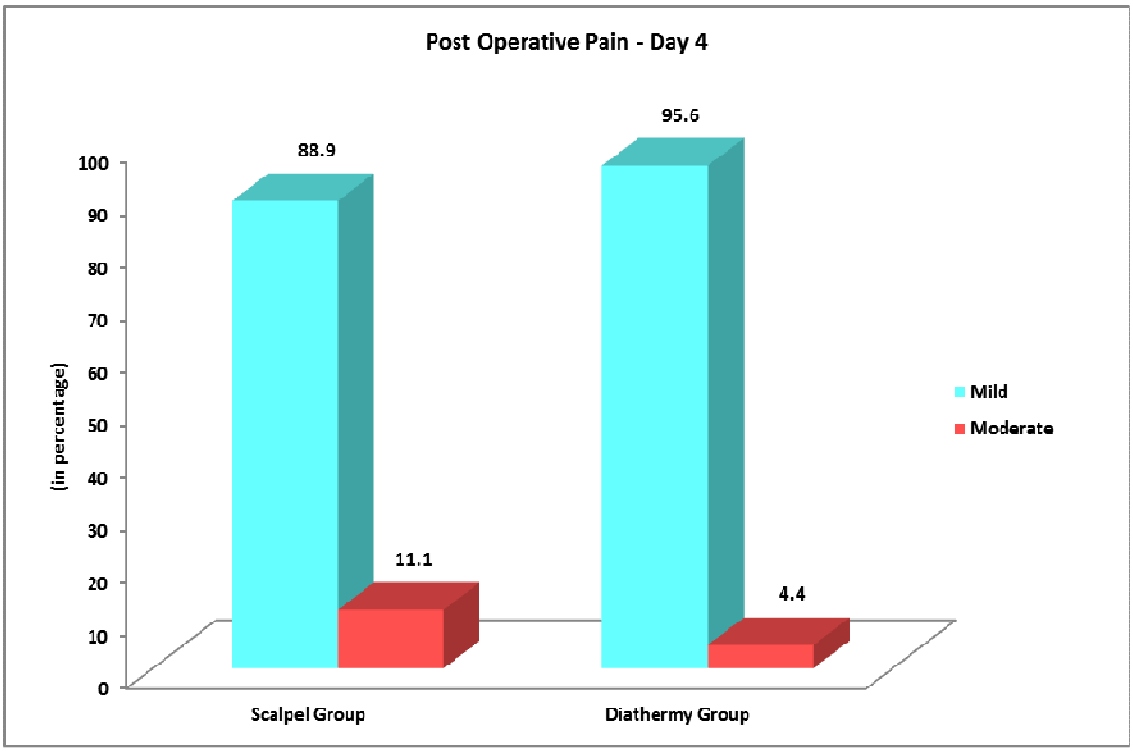
In post-operative day 3, there is apparent difference in post-operative pain as shown in the figure above.

POST-OPERATIVE PAIN

DAY-4

Pain Score Day4	**Scalpel Group (N=45)**	**Diathermy Group (N=45)**
Mild	40 (88.9%)	43 (95.6%)
Moderate	5 (11.1%)	2 (4.4%)
'P' value	**0.434**	

Fig.27



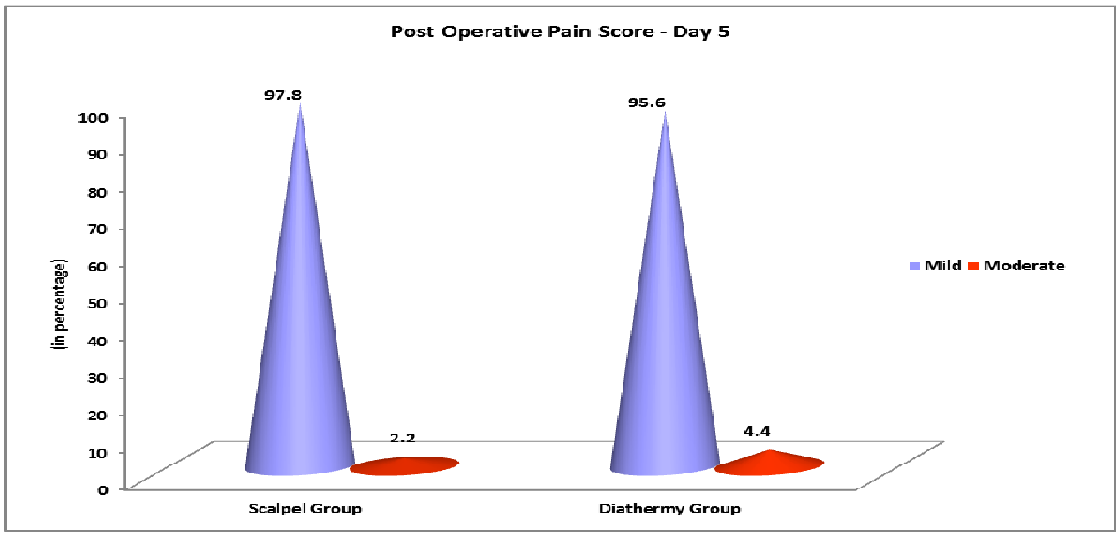
As the P-value is greater than 0.05, there is no significant difference in both groups with respect to post-operative pain.

POST-OPERATIVE PAIN

DAY-5

Pain Score Day 5	**Scalpel Group (N=45)**	**Diathermy Group (N=45)**
Mild	44 (97.8%)	43 (95.6%)
Moderate	1 (2.2%)	2 (4.4%)
'P' value	**1.000**	

Fig.28



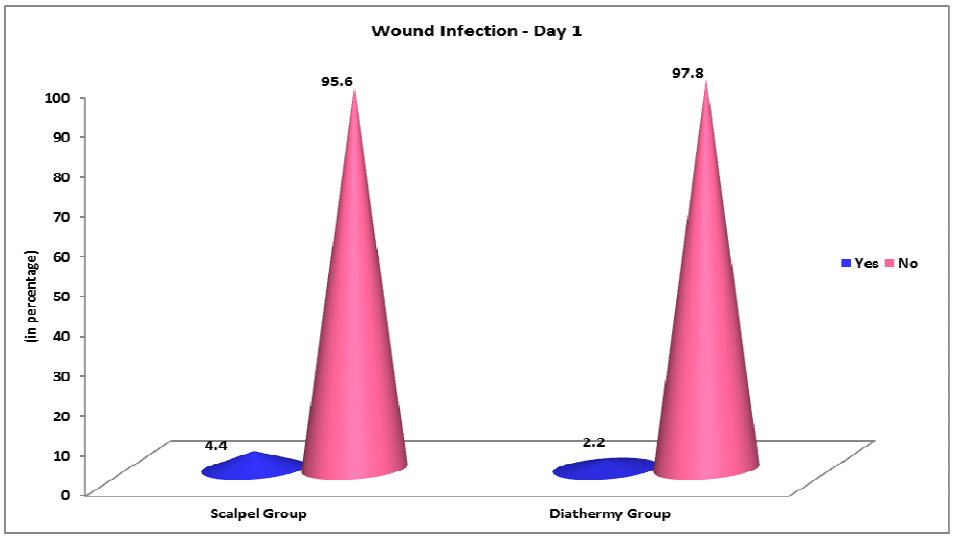
In post-operative day 5 , patients in both groups experience only mild and moderate pain. Even though ,in 2nd post-operative day there is an apparent increase in pain in diathermy group ,which is statistically insignificant.

WOUND COMPLICATION

DAY - 1

Wound Infection Day1	Scalpel Group (N = 45)	Diathermy Group (N = 45)
Yes	2 (4.4%)	1 (2.2%)
No	43 (95.6%)	44 (97.8%)
'P' value	**1.000**	

Fig. 29



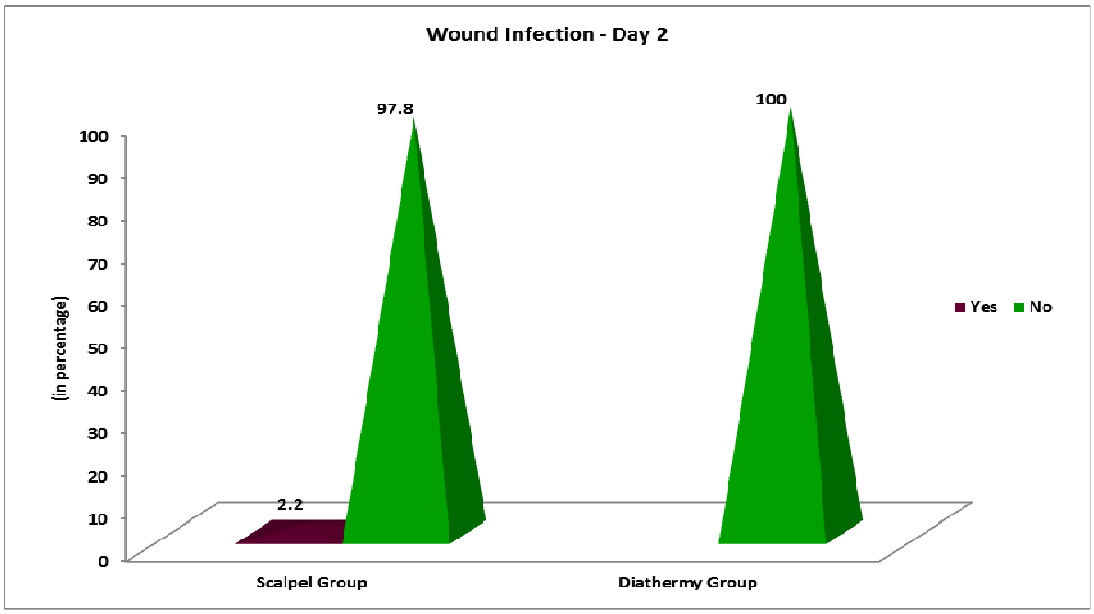
Wound complications in post-operative day 1. Both groups appears to have similar wound infection rate.

WOUND COMPLICATION

DAY - 2

Wound Infection Day2	Scalpel Group (N=45)	Diathermy Group (N=45)
Yes	1 (2.2%)	-
No	44 (97.8%)	45 (100.0)
'P' value	1.000	

Fig. 30

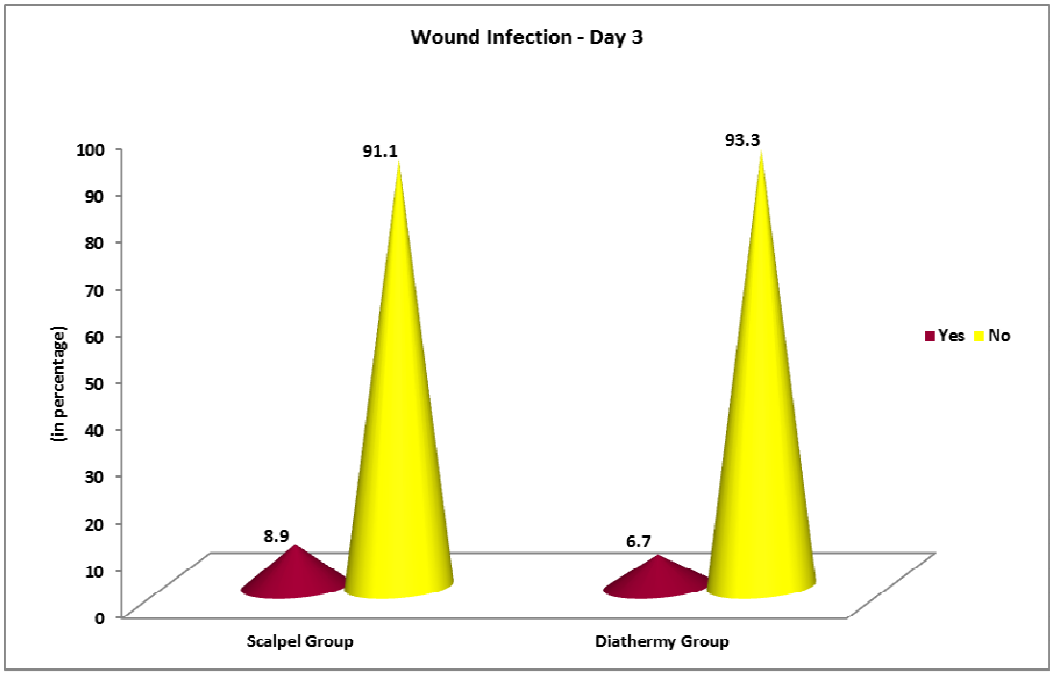


WOUND COMPLICATION

DAY - 3

Wound Infection – Day3	Scalpel Group (N=45)	Diathermy Group (N=45)
Yes	4 (8.9%)	3 (6.7%)
No	41 (91.1%)	42 (93.3%)
'P' - value	**1.000**	

Fig. 31

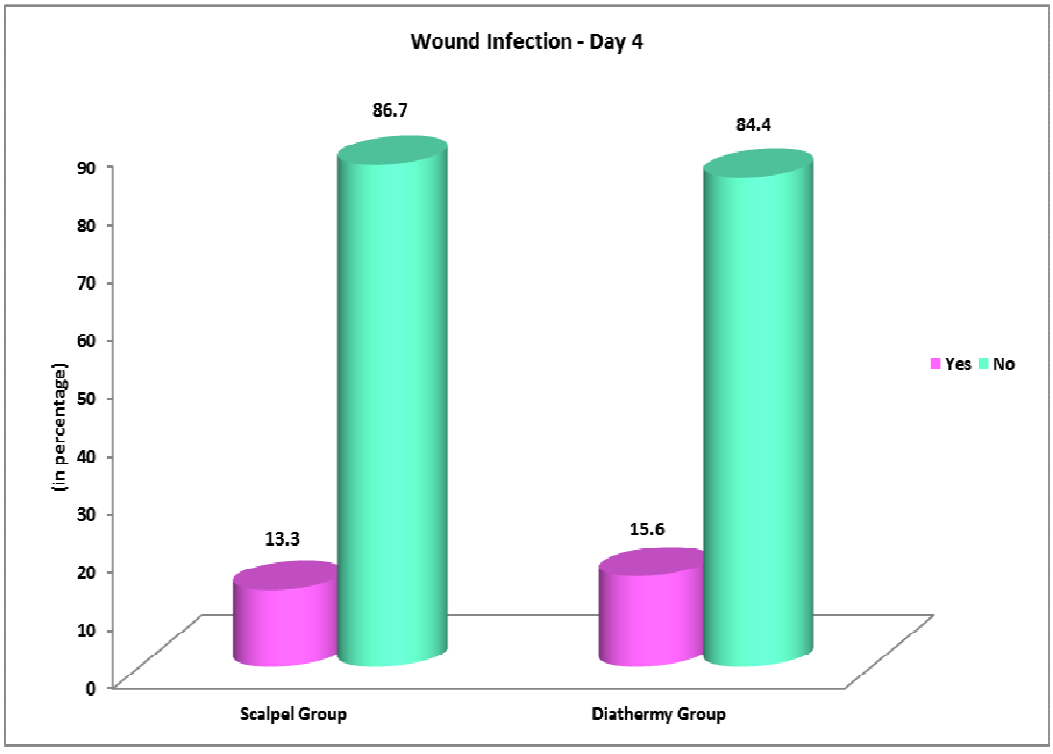


WOUND COMPLICATION

DAY - 4

Wound Infection – Day4	Scalpel Group (N=45)	Diathermy Group (N=45)
Yes	6 (13.3%)	7 (15.6%)
No	39 (86.7%)	38 (84.4%)
'P' value	**0.764**	

Fig.32

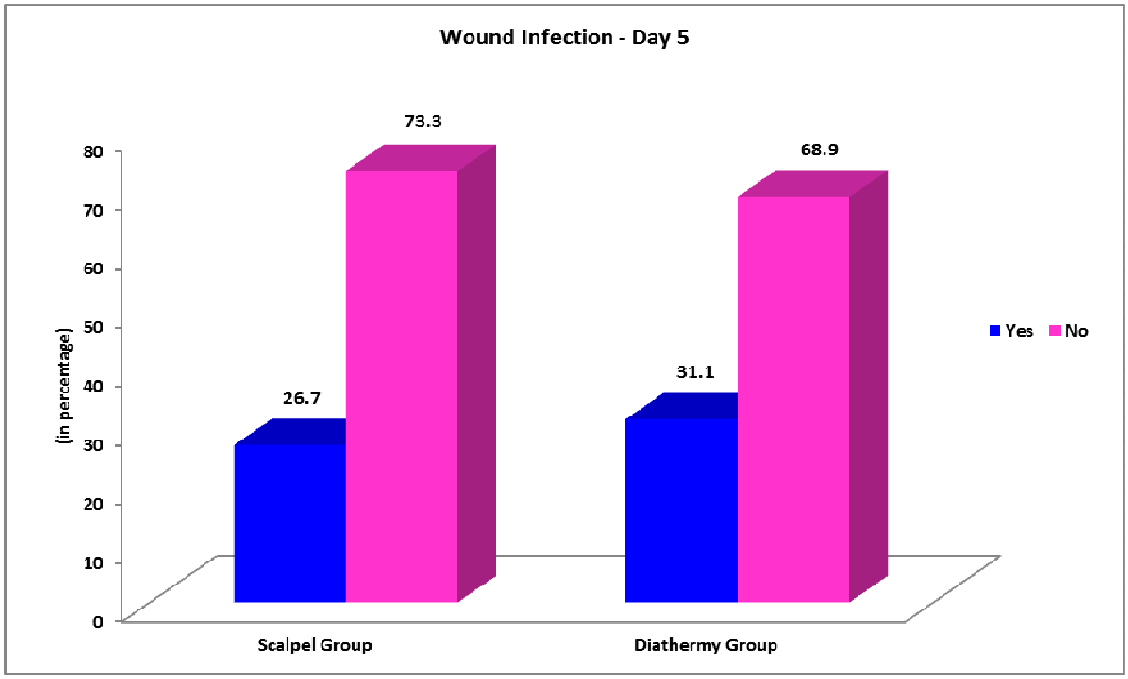


WOUND COMPLICATION

DAY-5

Wound Infection – Day5	Scalpel Group (N=45)	Diathermy Group (N=45)
Yes	12 (26.7%)	14 (31.1%)
No	33 (73.3%)	31 (68.9%)
'P' value	**0.642**	

Fig.33



Wound complications rate found to be similar in both groups. Even though, there is apparent difference in both the groups.

CONCLUSION

Based on the observations made in this study, it is concluded that the incision time and incision related blood loss is more in scalpel group when compared to diathermy group but post-operative pain and wound complications are similar in both diathermy and scalpel groups.

Diathermy can be effectively used as an alternative to scalpel for skin incision as there is no significant difference in post-operative wound complications in both groups.

Diathermy should be used for skin incision in monopolar cutting mode with power settings of 30 Watts. In this setting, there won’t be any tissue damage that affects the wound healing.

SUMMARY

Patients underwent skin incision through diathermy have shorter incision time and less incision related blood loss and there is no difference in the post-operative pain and post-operative wound complications.

After the study, it is concluded that the Diathermy can be used as an effective alternative to the Scalpel for skin incision. It does not affect wound healing while using mono-polar diathermy in power settings of 30Watts.

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ANNEXURE

"COMPARATIVE STUDY ON CUTTING DIATHERMY VERSUS SCALPEL INCISION IN ELECTIVE MIDLINE ABDOMINAL SURGERIES"

PROFORMA

Name of the Patient :

Age : I.P. No. :

Sex : D.O.A :

Occupation : D.O.S :

Address : D.O.D :

Surgical Unit :

CLINICAL DIAGNOSIS

INVESTIGATIONS :

I) Routine

a) Blood Hb: TC: DC:

ESR: BT: CT:

b) Urine Routine :

c) RBS /FBS :

d) Blood Urea : Serum Creatinine :

e) Serum Electrolytes

f) Liver Function Test :

g) HIV and HBsAg :

h) X-Ray Chest :

i) E.C.G

j) Specific investigation

II. Radiological investigation

- Plain erect x ray abdomen :
- Ultra sound abdomen and pelvis :
- Barium meal follow through :
- Barium Enema :

III. Endoscopy

Colonscopy :

FINAL DIAGNOSIS

PRE-OPERATIVE PREPARATION

- Nil orally overnight :
- Ryles Tube Insertion / Aspiration :
- Bowel wash
- Soap Water Enema :
- Antibiotics :

ANAESTHESIA :

- Elective
- Incision - Midline Abdominal

POST OPERATIVE FOLLOW-UP:

- Post Operative Pain
- Post Operative Wound Complications

FOLLOW UP :

SUMMARY :

S. No.	Name	Age/ Sex	IP Number	Group	Incision Time	Incision Related Blood Loss ml/cm^2	Post Operative Pain					Wound Complications				
							Day 1	Day 2	Day 3	Day 4	Day 5	Day 1	Day 2	Day 3	Day 4	Day 5
1	Mohan	36/M	61525	Diathermy	8.20	1.8	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
2	Savitha	29/F	26272	Scalpel	9.32	2.1	Sev	Mod	Mil	Mil	Mil	-	-	-	-	+
3	Ramya	43/F	61732	Diathermy	7.48	1.7	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
4	Raja	28/M	64737	Diathermy	8.43	1.7	Sev	Mod	Mil	Mil	Mil	-	-	-	-	+
5	Andrew	52/M	64567	Scalpel	8.46	2.3	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
6	Sangeeth	46/F	66753	Scalpel	7.52	1.7	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
7	Sanjitha	40/F	68949	Diathermy	8.48	1.8	Mod	Mil	Mil	Mil	Mil	-	-	-	-	+
8	Deepthi	39/F	69383	Diathermy	7.50	1.7	Mod	Mod	Mil	Mil	Mil	-	-	-	-	-
9	Chandran	51/M	73928	Scalpel	9.32	2.6	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
10	Ramu	19/M	77484	Diathermy	8.50	1.8	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
11	Ravi	26/M	74585	Scalpel	8.54	2.3	Mod	Mil	Mil	Mil	Mil	-	-	-	+	+
12	Sivakumar	28/M	72338	Scalpel	9.12	2.2	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
13	Dinesh	33/M	75849	Scalpel	9.48	2.6	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
14	Valli	58/F	76383	Scalpel	9.44	2.3	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
15	Saroja	42/F	70484	Scalpel	9.38	2.5	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
16	Vellai	61/F	79384	Diathermy	8.32	1.9	Mod	Mil	Mil	Mil	Mil	-	-	-	+	+
17	Muthupandi	48/M	77847	Diathermy	7.56	1.8	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
18	Lakshmi	44/F	83438	Diathermy	8.02	1.7	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
19	Pandi	38/M	85785	Diathermy	8.10	1.9	Mil	Mil	Mod	Mod	Mod	-	-	-	-	+
20	Devi	26/F	82235	Scalpel	9.14	2.2	Mil	Mil	Mod	Mod	Mod	-	-	-	-	+
21	Mahalakshmi	49/F	80343	Diathermy	8.22	1.8	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
22	Mohamad Ismail	50/M	80688	Scalpel	9.12	2.5	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
23	Babu	44/M	84648	Scalpel	9.44	2.4	Sev	Mod	Mil	Mil	Mil	-	-	+	+	+
24	Venkatesh	46/M	93857	Diathermy	8.22	1.6	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
25	Muthukaruppan	34/M	88373	Scalpel	8.56	2.1	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
26	Karthi	28/M	83438	Diathermy	8.02	1.9	Sev	Mod	Mil	Mil	Mil	-	-	+	+	+
27	Karppan	23/M	857854	Scalpel	9.08	2.6	Mod	Mod	Mil	Mil	Mil	-	-	-	-	-
28	Sasikala	19/F	82235	Diathermy	8.14	2.0	Mod	Mod	Mil	Mil	Mil	-	-	-	-	+
29	Hemanth	33/M	803434	Scalpel	9.46	2.6	Mod	Mod	Mil	Mil	Mil	-	-	-	-	+

30	Irulandi	31/M	806884	Diathermy	8.38	1.6	Mil	Mil	Mil	Mil	Mil	-	-	-	-	-
31	Petchiammal	48/F	84648	Diathermy	8.42	1.6	Mil	Mil	Mil	Mil	Mil	-	-	-	-	-
32	Visil	32/M	66544	Scalpel	9.16	2.3	Mil	Mil	Mil	Mil	Mil	-	-	-	-	-
33	Varatharajan	55/M	65434	Scalpel	9.22	2.2	Mil	Mil	Mil	Mil	Mil	-	-	-	-	-
34	Sampath	46/M	67845	Diathermy	7.52	1.9	Mod	Mil	Mil	Mod	Mod	-	-	-	+	+
35	Sharmila	41/F	75453	Scalpel	8.58	2.2	Mod	Mil	Mil	Mod	Mod	-	-	-	+	+
36	Parvathi	38/F	63322	Diathermy	8.22	1.6	Mod	Mil	Mil	Mil	Mil	-	-	-	-	+
37	Poppan	55/M	69854	Scalpel	9.22	2.6	Mod	Mil	Mil	Mil	Mil	-	-	-	-	+
38	Karuppaiah	47/M	74343	Scalpel	9.34	2.4	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
39	Selvam	43/M	72445	Diathermy	8.34	1.7	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
40	Idumban	29/M	71005	Scalpel	9.08	2.1	Mod	Mod	Mil	Mil	Mil	-	-	-	-	+
41	Ranjitha	33/F	74567	Diathermy	8.28	2.0	Mod	Mod	Mil	Mil	Mil	-	-	-	-	+
42	Paramasivam	53/M	74454	Diathermy	8.44	1.8	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
43	Jayakumar	60/M	79303	Scalpel	9.32	2.6	Sev	Mod	Mil	Mil	Mil	-	-	-	-	-
44	Vennila	26/F	80983	Diathermy	8.46	1.6	Sev	Mod	Mil	Mil	Mil	-	-	-	-	-
45	Varun	62/M	83838	Scalpel	9.22	2.5	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
46	Sathya	44/F	84433	Scalpel	9.12	2.5	Mil	Mil	Mil	Mil	Mil	-	-	-	-	-
47	Kumar	48/M	85783	Diathermy	9.02	1.9	Mil	Mil	Mil	Mil	Mil	-	-	-	-	-
48	Vijaya	36/F	86899	Diathermy	8.32	1.7	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
49	Vellaichamy	31/M	87939	Diathermy	8.54	2.0	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
50	Dhanam	27/F	88900	Diathermy	8.22	1.8	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
51	Vembu	48/M	78993	Scalpel	9.12	2.1	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
52	Karmegam	25/M	83647	Scalpel	9.33	2.7	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
53	Susila	34/F	90393	Scalpel	9.28	2.8	Sev	Mod	Mil	Mil	Mil	-	-	+	+	+
54	Stella	37/F	89887	Diathermy	8.48	1.9	Sev	Mod	Mil	Mil	Mil	-	-	+	+	+
55	Pandeeswari	25/F	89984	Scalpel	9.22	2.6	Mil	Mil	Mil	Mil	Mil	-	-	-	-	-
56	Irulandi	37/M	90039	Diathermy	8.40	1.6	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
57	Shanmugam	44/M	66544	Diathermy	8.38	1.7	Mil	Mil	Mil	Mil	Mil	-	-	-	-	-
58	Devika	53/F	65434	Scalpel	9.30	2.0	Mod	Mod	Mil	Mil	Mil	-	-	-	-	+
59	Vellaiammal	39/F	67845	Diathermy	8.22	1.8	Mod	Mod	Mil	Mil	Mil	-	-	-	-	+
60	Santhanakaruppan	45/M	75453	Scalpel	9.06	2.2	Mil	Mil	Mil	Mil	Mil	-	-	-	-	-
61	Murugan	48/M	63322	Scalpel	9.44	2.8	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
62	Ramar	52/M	69854	Scalpel	9.36	2.7	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-

63	Varathan	25/M	74343	Diathermy	8.06	1.9	Mil	Mil	Mil	Mil	Mil	-	-	-	-	-
64	Esther	34/F	72445	Diathermy	8.38	1.7	Mod	Sev	Mod	Mod	Mil	-	-	-	+	+
65	Jameelabeevi	46/F	71005	Scalpel	9.26	2.8	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
66	Thendral	37/F	74567	Diathermy	7.58	1.8	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
67	Sutha	49/F	74454	Diathermy	8.18	1.9	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
68	Nagarajan	36/M	79303	Diathermy	8.48	1.8	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
69	Jaya	51/F	80983	Scalpel	9.14	2.6	Mod	Sev	Mod	Mod	Mil	-	-	-	+	+
70	Natarajan	47/M	83838	Scalpel	9.32	2.8	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
71	Neelamegam	42/M	84433	Scalpel	9.24	2.9	Mod	Sev	Mod	Mil	Mil	-	-	-	-	-
72	Malar	43/F	85783	Diathermy	9.02	1.6	Sev	Mod	Mil	Mil	Mil	-	-	-	-	-
73	Iswarya	28/F	86899	Diathermy	8.36	1.8	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
74	Palani	53/M	87939	Diathermy	8.42	1.7	Mod	Sev	Mod	Mil	Mil	-	-	-	+	+
75	Periyakaruppu	58/M	88900	Scalpel	9.36	2.8	Mil	Mil	Mil	Mil	Mil	-	-	-	-	-
76	Sivanandi	60/M	78993	Scalpel	9.44	2.9	Sev	Mod	Mil	Mil	Mil	-	-	-	-	-
77	Kalpana	33/F	83647	Scalpel	9.52	2.8	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
78	Pothumponnu	42/F	90393	Diathermy	8.32	1.9	Mil	Mil	Mil	Mil	Mil	-	-	-	-	-
79	Asaithambi	35/M	89887	Scalpel	9.08	2.7	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
80	Chellapanai	33/M	89984	Scalpel	9.14	2.9	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
81	Muthuraj	38/M	90039	Scalpel	9.22	2.8	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
82	Pradeep	27/M	66544	Diathermy	9.02	1.6	Mod	Mil	Mod	Mil	Mil	-	-	-	-	-
83	Meenal	19/F	91393	Diathermy	8.44	1.5	Sev	Mod	Mod	Mod	Mil	-	-	+	+	+
84	Mathaliya	22/F	89487	Diathermy	8.36	1.5	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
85	Jayalakshmi	68/F	89284	Diathermy	8.42	1.6	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
86	Ravikumar	58/M	92039	Diathermy	8.32	1.7	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
87	Dhanam	46/F	66544	Scalpel	8.56	2.2	Sev	Mod	Mod	Mod	Mil	-	-	+	+	+
88	Ragavan	24/M	90293	Scalpel	8.52	2.3	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
89	Rajesh	33/M	87886	Diathermy	8.10	2.0	Mod	Mil	Mil	Mil	Mil	-	-	-	-	-
90	Veeran	55/M	89984	Scalpel	9.28	2.7	Mod	Mil	Mod	Mil	Mil	-	-	-	-	-

Abbreviation : Mil = Mild, Mod = Moderate, Sev = Severe, + = Present _ = Absent